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Galileo pp 100-101
1633

STILLMAN DRAKE

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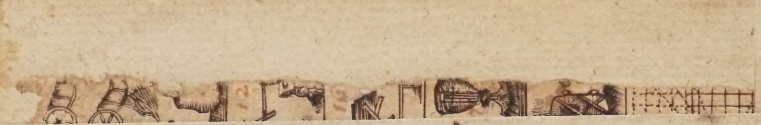

On the Frontiſpice and Booke.

ALL Recreations *do delight the minde,*
But theſe are beſt being of a learned kinde:
Here Art *and* Nature *ſtrive to give content,*
In ſhewing many a rare experiment;
Which you may reade, and on their Schemes here looke
Both in the Frontiſpice, *and in the* Booke.
Vpon whoſe table new conceits are ſet,
Like dainty diſhes, thereby for to whet
And winne your judgement, with your appetite
To taſte them, and therein to take delight.
The Senſes *objects are but dull at beſt,*
But Art *doth give the Intellect a feaſt.*
Come hither then, and here I will deſcribe,
What this ſame table doth for you provide.
Here Queſtions *of* Arithmeticke *are wrought,*
And hidden ſecrets unto light are brought,
The like is in Geometrie *doth unfold,*
And ſome too in Coſmographie *are told:*
In diverſe pretty Dyalls *doth deſcrie,*
With ſtrange experiments in Aſtronomie,
And Navigation *with each ſeverall* Picture,
In Muſicke, Opticks, *and in* Architecture:
In Staticke, Machanicks, *and* Chimeſtrie,
In Waterworkes, *and to aſcend more hie,*
In Fireworkes, *like to* Ioves Artillerie.
All this I know thou in this Booke *ſhalt finde,*
And here's enough for to content thy minde.
For from good Authors, *this our* Author *drew*
Theſe Recreations, *which are ſtrange, and true.*
So that this Booke's *a* Center, *and tis fit,*
That in this Center, *lines of praiſe ſhould meete.*

W.S.

Mathematicall Recreations.

Or a Collection of sundrie *Problemes*, extracted out of the Ancient and Moderne *Philosophers*, as secrets in nature, and experiments in *Arithmeticke, Geometrie, Cosmographie, Horologographie, Astronomie, Navigation, Musicke, Opticks, Architecture, Staticke, Machanicks, Chimestrie, Waterworkes, Fireworks*, &c. Not vulgarly made manifest untill this time: Fit for *Schollers, Students*, and *Gentlemen*, that desire to know the *Philosophicall* cause of many admirable Conclusions.

Usefull for others, to acuate and stirre them up to the search of further knowledge; and serviceable to all for many excellent things, both for pleasure and *Recreation*.

Most of which were written first in *Greeke* and *Latine*, lately compiled in *French*, by *Henry Van Etten* Gent. And now delivered in the *English tongue*, with the *Examinations, Corrections*, and *Augmentations*.

Printed at *London* by *T. Cotes*, for *Richard Hawkins*, dwelling in *Chancery Lane*, neere the *Rowles*, 163[illegible]

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TO
The thrice Noble and moſt generous Lo. the Lo. *Lambert* Verreyken, Lo. of *Hinden, Wolverthem, &c.*

My honorable Lo.

AMongſt the rare and curious Propoſitions which I have learned out of the ſtudies of the *Mathematicks* in the famous Vniverſitie of *Pont a Mouſſon*, I have taken

ken singular pleasure in certaine *Problemes* no lesse ingenious than recreative, which drew me unto the search of demonstrations more difficult and serious; some of which I have amassed and caused to passe the *Presse*, and here dedicate them now unto your *Honour*; not that I account them worthy of your view, but in part to testifie my affectionate desire to serve you, and to satisfie the curious, who delight themselves in these pleasant studies, knowing well that the *Nobilitie*, and *Gentrie* rather studie the *Mathematicall Arts*, to content and satisfie their affections, in the speculation of such admirable experiments as are extracted from them, than in hope of gaine to fill their *Purses*. All which studies, and others, with my

To the Reader.

IT hath beene observed by many, that sundry fine wits as well amongst the Ancient as Moderne, have sported and delighted themselves upon severall things of small consequence, as upon the foote of a fly, upon a straw, upon a point, nay upon nothing: striving as it were to shew the greatnesse of their glory in the smalnesse of the subject: And have amongst most solid and artificiall conclusions, composed and produced sundry Inventions both Philosophicall and Mathematicall

ticall, *to solace the minde, and recreate the spirits, which the succeeding ages have imbraced; and from them gleaned and extracted many admirable, and rare conclusions, judging that borrowed matter oftentimes yeelds praise to the industrie of its author. Hence for thy use (Courteous Reader) I have with great search and labour collected also, and heaped up together in a body of these pleasant and fine experiments to stirre up and delight the affectionate, (out of the writings of* Socrates, Plato, Aristotle, Demosthenes, Pythagoras, Democrates, Plinie, Hiparchus, Euclides, Vitruvius, Diaphantus Pergæus, Archimedes, Papi Alexandrinus, Vitelius, Ptolomeus, Copernicus, Proclus, Mauralicus, Cardanus, Valalpandus, Kepleirus, Gilbertus, Tychonius, Dureirus, Iosepheus, Clavius, Gallileus, Maginus, Euphanus

Tiberill

Tyberill, *and others*) *knowing that* Art *imitating nature, glories alwayes in the variety of things, which she produceth to satisfie the minde of curious inquisitors. And though perhaps these labours to some humorous persons may seeme vaine, and ridiculous; for such it was not undertaken. But for these which intentively have desired and sought after the knowledge of these things, it being an invitation and motive to the search of greater matters, and to imploy the minde in usefull knowledge, rather than to be busied in vaine* Pamphlets, Play-bookes, *fruitlesse* Legends, *and prodigious* Histories *that are invented out of fancie, which abuse many* Noble spirits, *dull their wits, & alienate their thoughts from laudable and honourable* studies. *In this* Tractate *thou maist therefore make choise of such* Mathematicall Problemes *and Conclusions as may de-*

delight thee; which kind of learning doth excellently adorne a man, seeing the usefulnesse thereof, and the manly accomplishments it doth produce: profitable and delightfull for all sorts of people, who may furnish and adorne themselves with abundance of matter in that kind, to helpe them by way of use, and discourse. And to this we have also added our Pyrotechnie, *knowing that* Beasts *have for their object onely the surface of the* earth; *but hoping that thy spirit which followeth the motion of* fire, *will abandon the lower* Elements, *and cause thee to lift up thine* eyes *to soare in a higher Contemplation, having so glittering a Canopie to behould; and these pleasant and recreative* fires *ascending may cause thy affections also to ascend. The Whole whereof we send forth to thee, that desirest the scrutabillity of things; Nature having furnished us with matter,*

thy

thy ſpirit may eaſily digeſt them,
and put them finely in
order, though now
in diſorder.

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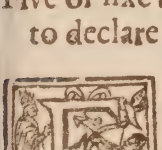
By vvay of advertiſement.

Five or ſixe things I have thought worthy to declare before I paſſe further.



Irſt, *that I place not the ſpeculative demonſtrations with all theſe* Problemes, *but content my ſelfe to ſhew them as at the* fingers end: *which was my* plot *& intention, becauſe theſe which underſtand the* mathematicks *can conceive them eaſily; others for the moſt part will content themſelves onely with the knowledge of them, without ſeeking the reaſon.*

Secondly, *to give a greater grace to the practiſe of theſe things, they ought to be concealed as much as they may, in the ſubtiltie of the way: for that which doth raviſh the ſpirits is,* an admirable effect, whoſe cauſe is unknowne: *which if it were diſcovered, halfe the pleaſure is loſt, therefore all the fineneſſe, con-*

consists in the dexterity of the Act, concealing the meanes, and changing often the streame.

Thirdly, *great care ought to be had that one deceive not himselfe, that would declare by way of Art to deceive another: this will make the matter contemptible to ignorant* Persons, *which will rather cast the fault upon the* Science, *than upon he that shewes it: when the cause is not in the* Mathematicall *principles, but in him that fayles in the acting of it.*

Fourthly, *in certaine* Arithmeticall *propositions they have onely their answers as I found them in sundry* Authors, *which any one being studious of* Mathematicall *learning, may finde their originall, and also the way of their operation.*

Fifthly, *because the number of these* Problemes, *and their dependences are many, and intermixed, I thought it convenient to gather them into a* Table: *that so each one according to his fancie, might make best choise of that which might best please his palet; the matter being not of one nature, nor of like subtiltie: But whosoever will have patience to reade on, shall finde the end better than the beginning.*

MATHEMATICALL RECREATION.

PROBLEME. I.

To finde a number thought upon.

BId him that hee Quadruple the *Number* thought upon, that is, multiply it by 4 and unto it bid him to adde, 6. 8. 10. or any *Number* at pleasure: and let him take the halfe of the summe, then aske how much it comes to: for then if you take away halfe the *Number* from it which you willed him at first to adde to it, there shall remaine the double of the number thought upon.

Example.

The *Number* thought upon.	5.
The Quadruple of it.	20.
Put 8. unto it, makes	28.
The halfe of it is	14.

Take away halfe the number added thō it, *viz.* 4. the rest is } 10.
The double of the number thought upon, *viz.* 10.

Another way to finde what number was thought upon.

Bid him which thinketh, double his *Number*, and unto that double adde 4. and bid him multiplie that same product by 5. and unto that product, bid him adde 12. and multiply that last *number* by 10. (which is done easily by setting a Ciphar at the end of the *number:*) then aske him the last number or product, and from it secretly subtract 320. the remainder in the hundreth place, is the *number* thought upon.

Example.

The *number* thought upon 7.	
His double 14.	
To it adde 4, makes 18.	
Which multiplied by 5. maks 90.	For which 700. account onely but the *number* of the hundreds *viz.* 7. so have you the *number* thought upon.
To which ad 12 makes 102.	
This multiplied by 10 which is onely by adding a Ciphar to it, makes 1020.	
From this subtract 320.	
Rest 700.	

To

To finde numbers conceived upon otherwise than the former.

BId the partie which thinkes the *number*, that he triple his thought, cause him to take the halfe of it: if it be odde take the least halfe and put one unto it: then will him to Triple the halfe and take halfe of it as before; lastly, aske him how many nines there is in the last halfe, and for every 9. account 4. in your memorie, for that shall shew the number thought upon, if both the Triples were even: but if it be odde at the first Triple, and even at the second, for the one added unto the least halfe keepe one in memorie: if the first Triple be even and the second odde, for the one added unto the least halfe keepe two in memorie: lastly if at both times in tripling, the numbers be odde, for the two added unto the least halfes, keepe three in memorie, these cautions observed and added unto as many fowes as the partie sayes there is nines contained in the last halfe, shall never faile you to declare, or discerne truly what *number* was thought upon.

Example.

The *number* thought upon,	4. or 7.
The Triple	12. or 21.
The halfe there of 6. or 10. 1 put to it makes	11.
The Triple of the halfe	18. or 33.
The halfe 6. or 16. 1 put to it maks	17.
The number of nines in the last halfe 1. or 1.	

The first 1. representeth the 4. number thought upon, and the last 1. with the caution makes 7. the other number thought upon.

Note.

Order your method so that you bee not discovered: which to helpe you may with dexteritie, and industrie make *additions*, *subtractions*, *multiplications*, *divisions*, *&c.* and in stead of asking how many nines there is: you may aske how many eights, tens, &c. there is, or subtract 8. 10. &c. from the *number* which remaines, for to finde out the *number* thought upon.

Now touching the *Demonstrations* of the former directions, and others which follow, they depend upon the 2. 7. 8. and 9. *Booke* of the Elements of *Euclid*: upon which 2. *Booke* and 4. *proposition* this may bee extracted for these which are more learned for the finding of any number that any one thinketh on.

Bid the partie that thinkes, that hee breake the *number* thought upon into any two parts, and unto the *squares* of the parts, let him adde the double product of the parts: then aske what it amounteth unto, so the *Root Quadrat* shall be the number thought upon.

The *number* thought upon 5. *the parts* suppose 3. and 2.

The

The *square* of 3. maks 9.
The *square* of 2. maks 4
The product of the parts *viz.* 3. by 2 makes 6. which 6. doubled makes 12

The summe of these three numbers 25. the *square Root* of which is 5. the number thought upon.

Or more compendiously, it may be delivered thus,

Breake the *number* into two parts, and to the product of the parts, adde the *square* of halfe the difference of the parts, then the *Root Quadrate* of the aggregate is halfe the *number* conceived.

EXAMINATION.

THe Problemes *which concern* Arithmetick, *we examine not, for these are easie to any one which hath read the grounds and principles of* Arithmeticke: *but we especially touch upon that, which tends to the speculations of* Physicke, Geometrie *and* Optickes, *and such others which are of more difficultie, and more principally to be examined and considered.*

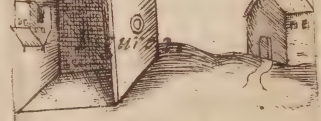
Problem. II.

How to represent to these which are in a chamber that which is without, or all that which passeth by.

THis is one of the finest experiments in the *Opticques*, and it is done thus, chuse a *Chamber* or place which is towards the street, frequented with people, or which is against some faire flourishing object, that so it may be more delightfull and pleasant to the beholders, then make the *Roome* darke by shutting out the light, except a small *hole* of sixe pence broad, this done, all the *Images* and species of the object which are without, will be seene within: and you shall have pleasure to see it not onely upon the wall but especially upon a sheete of white *paper* or some white cloth hung nere the *hole*: and if unto the *hole* you place a round *Glasse*, that is, a *Glasse* which is thicker in the middle than at the edge: such as is the common burning *Glasses*, or such which old people use, for then the *Images* which before did seeme dead, and

of

of a darkish colour, will appeare and be seene upon the paper, or white *cloth*, according to their naturall colours, yea more lively than their naturall; and the appearances will be so much the more beautifull, and perfect, by how much the *hole* is lesser, the day cleare & the sun *shining*. It is pleasure to see the beautifull and goodly representation of the *Heavens*, intermixed with *clouds* in the *Horizon*, upon a wooddy situation, the motion of *Birds* in the *Aire*, of *Men*, and other *Creatures* upon the ground, with the trembling of *Plants*, tops of *Trees*, and such like, for every thing will be seene within even to the life, but inversed: notwithstanding this beautifull paint will so naturally represent it selfe in such a lively *perspective*, that hardly the most accurate *Painter* can represent the like. Now the reason why the *Images* and objects without are inversed, is because the *species* doe intersect one another in the *hole*: so that the *species* of the *feet* ascend, and these of the head descend.



But heere note, that they may be Represented right two manner of wayes; first with a *concave glasse*, secondly, by helpe of another *convex glasse*: disposed or placed betweene the paper and the other *Glasse*: as may

be seene here by the *figure*.

Now I will adde here onely by passing by, for such which affect painting, and portraiture, that this experiment may excellently helpe them, in the lively painting of things perspective wise, as *Topographicall cards*, *&c.* and for philosophers, it is a fine secret to explaine the organ of the *sight*, for the hollow of the *eye* is taken as the *close Chamber*, the balle of the Aple of the *eye*, for the *hole* of the *Chamber*, the *Crystalline Humor* at the small of the *Glasse* and the bottome of the *eye*, for the *wall*, or leafe of *Paper*.

EXAMINATION.

IT is false that the species being prest together or contracted doth performe it upon a wall, for the species of any thing doth represent it selfe not onely in one hole of a window, *but in infinite holes; even unto the whole* Spheare, *or at least unto a* Hemisphere (*intellectuall in a free medium*) *if the beames or reflections be not interposed, & by how much the* hole *is made lesse to give passage to the species, by so much the more lively are the* Images *formed.*

In convexe, or concave Glasses *the* Images will *be disproportionable to the* eye, *by how much they are more concave, or convexe, and by how much*

much the parts of the Image *comes neare to the* Axis, *for these that are neare are better proportionated, than these which are farther off.*

But to have them more lively, and true, according to the imaginarie conicall section, let the hole be no greater than a pins head made upon a peece of thinne Brasse, *or such like, which hole represents the top of the* Cone, *and the Base thereof the terme of the species: this practice is best when the* Sunne *shines upon the* hole, *for then the objects which are opposite to that plaine, will make two like* Cones, *and will lively represent the things without, in a perfect inversed perspective, which drawne by the* Pensell *of some artificiall* Painter, *turne the paper upside downe, and it will be direct, and to the life.*

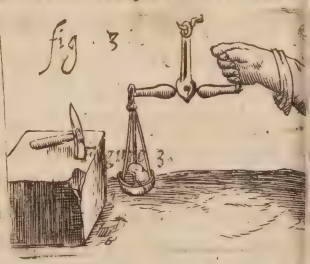
But the apparences may be direct, if you place another hole *opposite unto the former so that the spectator be under it; or let the species reflect upon a Concave* Glasse, *and let that* Glasse *reflect upon a paper, or some white thing.*

Problem. III.

To tell how much waighs the blow of ones fist, of a Mallet, Hatchet or such like, or resting without giving the blow.

Caliger in his 331. exercise against *Cardan*, relates that the *Mathematitians* of *Maximilian* the *Emperour* did propose upon a day

this *Question*, and promised to give the resolution; notwithstanding *Scaliger* delivered it not, and I conceive it to be thus. Take a *Balance*, and let the fist, the *Mallet* or Hatchet rest upon the *Scale* or upon the beame of the *Ballance*; and put into the other *scale*, as much weight as may counterpoyse it; then charging or laying more waight into the *Scale*, and striking upon the other end: you may see how much one *blow* is heavier than another, and so consequently how much it may waygh: for as *Aristotle* saith; *the motion that is made in striking ads great waight unto it, and so much the more, by how much it is quicker*: therefore in effect if there were placed a thousand *mallets*, or a thousand pound waight upon a stone, nay though it were exceedingly pressed downe by way of a vice, by levers or other mechanick *Ingine*, it would be nothing to the rigor and violence of a blow.



Is it not evident that the edge of a *knife* laid upon *butter*, and a *hatchet* upon a leafe of *Paper*, without striking makes no impression, or at least enters not; but striking upon the *wood* a little, you may presently see what effect it hath, which is from the quickness of the motion, which breakes and enters without resistance, if

it be extreame quicke, as experience ſhewes s, in the blowes of *Arrows*, of *Cannons*, *Thun-erboults*, and ſuch like.

EXAMINATION.

This Probleme *was extracted from* Scaliger, *who had it from* Ariſtotle, *but ſomewhat refractory compiled, and the ſtrength of the effect he ſayes depends onely in the violence of the motion; then would it follow that a little ight* hammer *upon a peece of* wood *being quick- caused to ſmite, would give a greater blow and e more hurt than a great ſledge ſtriking ſoft; his is abſurd, and contrary to experience: there-re it conſiſts not totally in the motion, for if two verall hammers, the one being 20. times hea-ier than the other, ſhould move with like quick-ſſe, the effect would be much different: there then ſome thing elſe to be conſidered beſides the lotion which* Scaliger *underſtood not, for if e ſhould have asked him, what is the reaſon at a* ſtone *falling from a* window *to a place eare at hand is not ſo forceable, as if it fell far-er downe; and when a bullet flying out of a eece and ſtriking the marke neare at hand, ill not make ſuch an effect as ſtriking the marke rther off: but wee ſuppoſe that* Scaliger *and ardanus who handles this ſubject, would not*

bee

bee leſſe troubled to reſolve this, than they have beene in that.

Problem. IIII.

How to breake a ſtaffe which is laid upon two Glaſſes full of water, without breaking the Glaſſe, ſpilling the water, or upon two Reeds or Strawes without breaking of them.

FIrſt place the *Glaſſes* which are full of *water* upon two *joynt ſtooles*, or ſuch like, the one as high as the other from the ground, and diſtant one from another by 2. or 3. foote, then place the ends of the *ſtaffe* upon the edges of the two *Glaſſes* ſo that they bee ſharpe; this done with all the force you can, with another *ſtaffe* ſtrike the *ſtaffe* which is upon the two *Glaſſes* in the middle, and it will breake without breaking the *Glaſſes* or ſpilling the *water*. In like manner may you doe upon two *Reeds*, held in the *aire* without breaking them: thence *Kitchin-boyes* often breake *bones* of *mutton* upon their hand, or with a

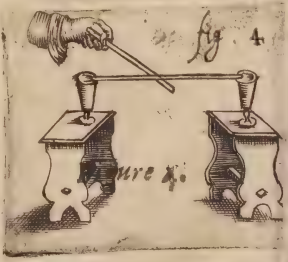


fig. 4.

figure 4.

napkin

napkin without any hurt, in onely striking upon the middle of the bone, with a *knife*.

Now in this act the two ends of the *staffe* in breaking slides away from the Glasses, upon which they were placed; hence it commeth that the *Glasses* are no wise indangered, no more than the knee upon which a *staffe* is broken, for asmuch as in breaking it presseth not: as *Aristotle* in his *Mechanicke questions* observeth.

EXAMINATION.

IT were necessary here to note, that this thing may be experimented, first, without Glasses, *in placing a small slender* Staffe *upon two props, and then making tryall upon it, by which you may see how the* Staffe *will either breake, bow, or depart from his props: and that eyther directly, or obliquely: But why by this violence, that one* Staffe *striking another, (which is supported by two* Glasses) *will bee broken without offending the* Glasses, *is as great a difficultie to be resolved as the former.*

PROP-

PROBLEM. V.

How to make a faire Geographicall Card in a Garden Plot, fit for a Prince, or great personage.

IT is usuall amongst great men to have faire *Geographicall mappes*, large *Cards*, and great *Globes*, that by them they may as at once have a view of any place of the world, and so furnish themselves with a generall knowledge, not onely of their owne *kingdomes* forme, situation, *Longitude*, *Latitude*, &c. but of all other places in the whole Vniverse, with their *Magnitudes*, *Positions*, *Climats*, and distances.

Now I esteeme that it is not unworthy for the meditations of a *Prince*, seing it carries with it many profitable and pleasant contentments: if such a *Card* or *Mappe* by the advice and direction of an able *Mathematitian* were *Geographically* described in a *Garden plot forme*, or in some other convenient place; and in stead of which generall description might particularly, and Artificially be prefigured his whole *kingdomes* and dominions, the *Mountaines* and *Hils* being raised like small *hillocks* with turfes of *earth*, the *vallies* somewhat concave; which will be more agreeable & pleasing to the *Eye*, than the description in plaine *Mapps* and *Cards*, within which may be presented, the *townes*, *villages*, *Castles*, or other remarkeable *edifices* in small greene *Mossie* bankes or *springworke* proportionall to the *plat forme*

th

he *forrests* and *woods* represented according to heir forme and capacitie, with hearbs and oubs, the great *rivers*, *lakes* and *ponds*, to dilate hemselves according to their course from ome Artificiall *fountaine* made in the *Garden* o passe through *Chanels*; then may there bee ompoſed *walkes* of pleasure, *Ascents*, places f repoſe adorned with all varietie of delightfull *hearbs* & *flowers*, both to pleaſe the *eye*, r other ſences. A *Garden* thus accommodated hall farre exceede that of my *Lo.* of *Verulams* pecified in his Eſſayes; that being onely for lelight and plaſure, this may have all the properties of that, and alſo for ſingular uſe, by which a *Prince* may in little time perſonally viſite his whole *kingdome*, and in ſhort time know them diſtinctly, and ſo in like manner may any particular man *Geographically* prefigure his owne poſſeſſion, or heritage.

Problem. VI.

How three ſtaves, knives, or like bodies may be conceaved to hang in the Aire, without being ſupported by any thing, but by themſelves.

TAke the firſt *ſtaffe A. B.* raiſe up in the *Aire*, the end *B.* and upon him croſwiſe place the *ſtaffe C. B.* then laſtly in *Triangle* wiſe place the third *ſtaffe* E. F. in ſuch manner that it may be under *A. B.* and yet upon *C. D.* I ſay that theſe ſtaves ſo diſpoſed cannot fall, and the

the ſpace *C.B.E.* is made the ſtronger, by how much the more it is preſſed downe, if the *ſtaves* breake not, or ſever themſelves from the *triangular* forme: ſo that alwayes the Center of gravitie be in the Center of the *Triangle*: for *A.B.* is ſupported by *E. F.* and *E. F.* is helde up by *C. D.* and *C. D.* is kept up from falling by *A. B* therefore one of theſe *ſtaves* cannot fall, and ſo by conſequence none.

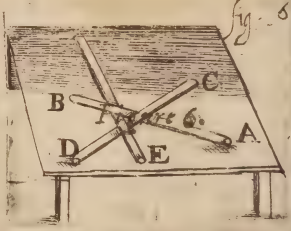


Fig. 6
Figure 6.

PROBLEM VII.

How to diſpoſe as many men, or other things, in ſuch ſort that rejecting, or caſting away the 6.9.10. part, unto a certaine number, there ſhall remaine theſe which you would have.

ORdinarily the propoſition is delivered in this wiſe: 15. *Chriſtians* and 15. *Turkes* being at Sea in one *Shippe*, an extreame tempeſt being riſen, the Pilot of the *Shippe* ſay it is neceſſary to caſt over board halfe of the number of *Perſons* to diſburthen the *Shippe*, and

to

to save the rest: now it was agreed to bee done by *lot* and therefore they content to put themselves in ranke, counting by nine and nine the ninth *Person* should alwayes be cast into the *Sea*, untill there were halfe throwne over board; Now the *Pilote* being a *christian* indeavoured to save the *Christians*, how ought hee therefore to dispose the *Christians*, that the *lot* might fall alwayes upon the *Turkes*, and that none of the *Christians* be in the ninth place?

The resolution is ordinarily comprehended in this verse,

Populeam virgam mater regina ferebat.

For having respect unto the vowels, making *a* one, *e* two, *i* three, *o* foure and *u* five: *o* the first vowell in the first word sheweth that there must bee placed 4. *Christians*, the next vowell *u*, signifieth that next unto the 4. *Christians* must be placed 5. *Turkes*, and so to place both *Christians* and *Turkes* according to the quantitie and value of the vowels in the words of the verse, untill they be all placed: for then counting from the first *Christian* that was placed, unto the ninth, the *lot* will fall upon a *Turke*, and so proceede. And here may be further noted that this *Probleme* is not to bee limited, seeing it extends to any *number* and order whatsoever, and may many wayes bee usefull for *Captaines*, *Magistrats*, or others which have divers *persons* to punish, and would chastise chiefely the unrulieſt of them, in taking the 10. 20. or 100. person, &c. as we reade was

commonly practised amongst the ancient *Romans*: herefore to apply a generall rule in counting the third, 4. 9. 10. &c. amongst 30. 40. 50. persons, and more or lesse; this is to bee observed: take as many unites as there are *persons*, and dispose them in order privately: as for example, let 24. *men* bee proposed to have committed some outrage, 6. of them especially are found accessary: and let it be agreed that counting by 8 and 8. the eight man should be alwayes punished: Take therefore first 24. unites, or upon a peece of paper write downe twenty foure Ciphars, and account from the beginning to the eighth, which eighth marke, and so continue counting alwayes marking the eighth, untill you have markt 6. by which you may easily perceive how to place those 6. men that are to bee punished, and so of others. It is supposed that *Iosephus* the Author of the *Iewish History*, escaped the danger of death by helpe of this *Probleme*; for a worthy Author of beliefe reports in his eighth Chapter of the third Booke of the destruction of *Ierusalem*, that the Towne of *Iotapata* being taken by maine force by *Vespatian*; *Iosephus* being governour of that Towne accompained with a troope of 40. Souldiers, hid themselves in a *Cave* in which they resolved rather to famish than to fall into the hands of *Vespatian*: and with a bloody resolution in that great distresse would have butchered one another for sustenance: had not *Iosephus* perswaded them to die by

lot.

lot, and order, upon which it should fall: Now seeing that *Iosephus* did save himselfe by this Art: It is thought that his industrie was exercised by the helpe of this *Probleme*; so that of the 40 persons which hee had, the third was alwayes killed. Now by putting himselfe in the 16. or 31. place he was saved, and one with him which hee might kill, or easily perswade to yeeld unto the *Romans*.

PROBLEM. VIII

Three things, and three persons proposed, to finde which of them hath either of these three things.

LEt the three things bee a *Ring*, a peece of *Gold*, and a peece of *Silver*, or any other such like, and let them bee knowne privatly to your selfe, by these three vowels, *a e i*: or let there bee three persons that have different names, as *Ambrose*, *Edmond* and *Iohn*; which privatly you may note or account to your selfe once knowne by the aforesaid vowels, which signifie for the first vowell 1. for the second vowell 2. for the third vowell 3.

Now if the sayd three persons should by the mutuall consent of each other privatly change their names, it is most facill by the course and excellencie of numbers, distinctly to declare each ones name, so interchanged: or of three *persons* in private, the one should take a *Ring*, the

other a peece of *Gold*, and the third should take a peece of *Silver*; it is easie to finde which hath the *Gold*, the *Silver*, or the *King*, and it is thus done.

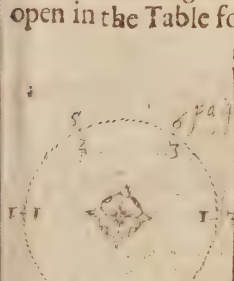
Take 30 or 40. *Counters* (of which there is but 24. necessary) that so you may conceale the way the better, and lay them downe before the parties, and as they sit or stand give to the first 1. *Counter*, which signifieth *a* the first vowell, to the second 2. *Counters* which represents *e* the second vowell, and to the third 3. *Counters* which stands for *i*. the third vowell: then leaving the other *Counters* upon the *Table*, retire apart, and bid him which hath the *Ring*, take as many *Counters* as you gave him, and hee that hath the *Gold*, for every one that you gave him, let him take 2. and he that hath the *Silver* for every one that you gave him let him take 4. this being done, consider to whom you gave one *Counter*, to whom two, and to whom three; and marke what number of *Counters* you had at the first, for there are necessarily but 24. as was sayd before, the surplusse you may privately reject. And then there will be left either 1. 2. 3. 5. 6. or 7. & no other number can remaine, w^ch^ if there be, then they have failed in taking according to the directions delivered: but if either of these numbers doe remaine, the resolution will bee discovered by one of these 6. words following, which ought to be had in memory, *viz.*

Salve, certa, anima, semita, vita, quies.

1. 2. 3. 5. 6. 7.

As

As suppose 5. did remaine, the word belonging unto it is semita, the vowels in the first two sillables are *e* and *i*, which sheweth according to the former directions that to whom you gave 2. *Counters* he hath the *Ring* (seeing it is the second vowell represented by two as before) and to whom you gave the 3. *Counters* he hath the *Gould*, for that *i* represents the third vowell, or 3. in the former direction, and to whom you gave one *Counter*, he hath the *Silver*, and so of the rest: the varietie of changes in which exercise, is layd open in the Table following.



rest	men	hid	rest	men	hid
1	1	*a*	5	1	*e*
	2	*e*		2	*i*
	3	*i*		3	*a*
2	1	*e*	6	1	*i*
	2	*a*		2	*a*
	3	*i*		3	*e*
3	1	*a*	7	1	*i*
	2	*i*		2	*e*
	3	*e*		3	*a*

This feat may be done also without the former words by helpe of the *Circle A.* for having divided the *Circle* into 6. parts, write 1. within and 1. without, 2. within and 5. without, &c. the first 1. 2. 3. which are within with the numbers over them, belongs to the upper semicircle; the other *numbers* both within and without, to the under *semicircle*;

now if in the Action there remaineth such a *number* which may bee found in the upper *semicircle* without, then that which is opposite within shewes the first, the next is the second, &c. as if 5. remaines, it shewes to whom hee gave 2. hee hath the *Ring*, to whom you gave 3. hee hath the *Gould &c.* but if the remainder bee in the under *semicircle*, that which is opposite to it, is the first; the next backwards towards the right hand is the second, as if 3. remaines, to whom you gave 1. he hath the *Ring*; he that had 3. he had the *Gould, &c.*

Problem. IX.

How to part a vessell which is full of wine containing 8. *Pints, into two equall parts, by two other vessels which contained as much as the greater vessell; as the one being* 5. *Pints, and the other* 3. *Pints.*

LEt the 3. *vessels* be represented by *A.B.C.* *A.* being full, the other two being emptie; first powre out *A.* into *B.* untill it bee full: so there will be in *B.* 5. *Pints* and in *A.* but 3. *Pints*; then powre out of *B.* into *C.* untill it bee full: so in *C.* shall be 3. *Pints*, in *B* 2. *Pints*, and in *A* 3. *Pints*; then powre the wine which is in *C.* into *A.* so in *A.* will be 6. *Pints*, in *B* 2. *Pints*, and in *C.* nothing: then powre out the wine which is in *B.* into the pot *C.* so in *C.* there

there is now 2. *Pints*, in *B*. nothing, and in *A*. 6. *Pints*. Lastly, powre out of *A*. into *B*. untill it be full, so there will bee now in *A*. onely 1. *Pint*, in *B*. 5. *Pints*, and in *C*. 2. *Pints*: But it is now evident that if from *B*. you powre in unto the pot *C*. untill it bee full, there will remaine in *B*. 4. *Pints*, and if that which is in *C*. *viz*. 3 *Pints* bee powred into the vessell *A*. which before had 1. *Pint*, there shall bee in the vessell *A* but halfe of its liquor that was in it at the first, *viz* 4. *Pints* as was required. Otherwise powre out of *A*. into *C*. until it be full, which powre into *B* then powre out of *A*. into *C*. againe untill it bee full, so there is now in *A*. onely 2. *Pints*, in *B*. 7, and in *C* 3. then powre from *C* into *B*. untill it bee full, so in *C*. there is now but 1. *Pint*, 5. in *B*. and 2. in *A*. powre all that is in *B*. into *A*. then powre the *wine* which is in *C*. into *B*. so there is in *C*. nothing, in *B*. onely 1 *Pint*, and in *A* 7. *Pints*: Lastly out of *A*. fill the pot *C*. so there will remaine in *A*. 4. *Pints*, or be but halfe full: then if the liquor in *C*. bee powred into *B*. it will bee the other halfe. In like manner might bee taken the halfe of a vessell which containes 12. *Pints*, by having but the measures 5. and 7. or 5. and 8. Now such

ſuch others might be propoſed, but wee omit many, in one and the ſame nature.

Problem. X.

To make a ſticke ſtand upon the tipp of ones finger, without falling.

FAſten the edges of two knives or ſuch like of equall poiſe, at the end of the *ſticke*, leaning out ſomewhat from the *ſticke*, ſo that they may counterpoiſe one another; the *ſticke* being ſharpe at the end and held upon the top of the *finger*, will there reſt without ſupporting: if it fall it muſt fall together, and that perpendicular or plumbe wiſe, or it muſt fall ſide-wiſe or before one another; in the firſt manner it cannot: for the Center of gravitie is ſupported by the top of the finger: and ſeeing that each part by the *knives* is counterpoyſed it cannot fall ſidewiſe, therefore it cannot fall no wiſe.

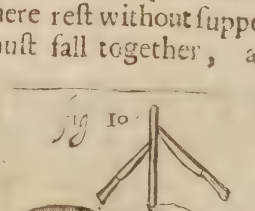


Figure 10.

In like manner may great peeces of *Timber* as *Ioiſts* &c. be ſupported, if unto one of the ends be applyed convenient proportionall counterpoiſes, yea a *Lance* or *Pike*, may ſtand prepen-

perpendicular in the Aire upon the top of ones *finger*: or placed in the midst of a *Court* by helpe of his Center of gravitie.

EXAMINATION.

THis Propoſition *ſeemes doubtfull for to imagine abſolutely, that a* Pike, *or ſuch like, armed with two* knives, *or other things ſhall ſtand upright in the* Ayre, *and ſo remaine without any other ſupport, ſeeing that all the parts hath an infinite difference of propenſitie to fall; and it is without queſtion that a* ſtaffe *ſo accõmodated upon his* Center of gravitie, *but that it may incline to ſome one part without ſome remedie be applyed, and ſuch as is here ſpecified in the* Probleme *will not warrant the thing, nor keepe it from falling; and if more* knives *ſhould be placed about it, it ſhould cauſe it to fall more ſwiftly, for aſmuch as the ſuperiour parts (by reaſon of the* Centricall motion) *is made more ponderous and therefore leſſe in reſt.*

To place therefore this prop really, let the two knives, *or that which is for counterpoiſe, be longer alwaies than the* ſtaffe *and ſo it will hang together as one body: and it will appeare admirable if you place the* Center of gravitie, *neare the ſide of the top of the finger or point; for it will then hang* Horizontall, *and ſeeme to hang onely by a touch, yet more ſtrange if you turne the point or top of the finger upſide downe.*

PROB.

PROBLEM. XI.

How a milſtone or other Ponderoſitie, may be ſupported by a ſmall needle, without breaking or any wiſe bowing the ſame.

LEt a needle be ſet perpendicular to the *Horizon*, and the center of gravitie of the *ſtone*, be placed on the top of the *Needle*: it is evident that the *ſtone* cannot fall, for aſmuch as it hangs in *æquilibra*, or is counterpoyſed in all parts alike; and moreover it cannot bow the *Needle* more on the one ſide, than on the other, the *Needle* will not therefore be eyther broken or bowed; if otherwiſe, then the parts of the *Needle* muſt penitrate and ſinke one with another: that which is abſurd and impoſſible to nature: therefore it ſhall be ſupported. The experiments which are made upon trencher plates, or ſuch like leſſer thing doth make it moſt credible in greater bodies.

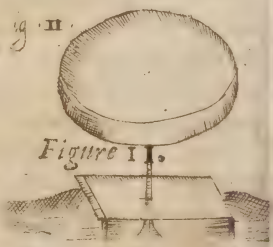


Figure II.

But here eſpecially is to bee noted that the *Needle* ought to be uniforme in *matter* and figure, and that it be erected perpendicular to the *Horizon*, and laſtly that the *Center* of *gravitie* be exactly found.

PROB.

PROBLEM. XII.

To make three knives hang and move upon the point of a Needle.

FIt the three *knives* in forme of a *ballance*, and houlding a *Needle* in your hand, and place the backe of that *knife* which lies crossewise to the other two, upon the point of the *Needle:* as the figure here sheweth you; for then in blowing softly upon them, they will easily turne & move upon the point of the *needle* without falling.

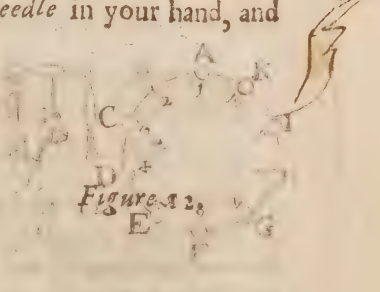


Figure 12.

PROBLEM. XIII.

To finde the weight of smoake, which is exhaled of any combustible body whatsoever.

LEt it be supposed that a great heape of *Fagots*, or a load of *straw* waying 500.l should be fired, it is evident that this grosse substance will bee all inverted into *smoake* and *Ashes*: now it seemes that the *smoake* waighes nothing; seeing it is of a thinne substance now delated in the *Aire*, notwithstanding if it were gathered and reduced into the thickest

keſt that it was at firſt, it would bee ſenſibly waighty: waigh therefore the *aſhes* which admit 50 pound, now ſeeing that the reſt of the matter is not loſt, but is exhaled into *ſmoke*, it muſt neceſſarily bee, that the reſt of the waight (to wit) 450 pound, muſt bee the waight of the *ſmoke* required.

EXAMINATION.

NOw although it bee thus delivered, yet here may be noted, that a ponderoſitie *in his owne* medium *is not waightie: for things are ſayd to be waighty, when they are out of their place, or medium: and the difference of ſuch gravitie, is according to the motion: the* ſmoke *therefore certainely is light being in its true* medium *(the* ayre*) if it ſhould change his* medium, *then would we change our diſcourſe.*

PROBLEM. XIIII.

Many things being diſpoſed circular, (or otherwiſe) to find which of them, any one thinkes upon.

SUppoſe that having ranked 10 things, as *A B C D E F G H I K, Circular* (as the figure ſheweth) and that one had touched or thought upon *G.* which is the 7: aske the partie at what letter he would begin to account (for ac-

count he must, otherwise it cannot bee done) which suppose, at *E* which is the 5 place, then ad secretly to this 5. 10. (which is the number of the *Circle*) and it makes 15, bid him account 15. backward from *E*, beginning his account with that number hee thought upon, so at *E* hee shall account to himselfe, 7, at *D* account 8, at *C* account 9 &c. So the account of 15 will exactly fall upon *G*, the thing or number thought upon: and so of others: but to conceale it the more, you may will the party from *E* to account 25. 35 &c. and it will be the same.

Figure 16.

There are some that use this play at cards, turned up side downe, as the ten simple *Cards*, with the *King* and *Queene*, the *King* standing for 12, and the *Queene* for 11, and so knowing the scituation of the *Cards*: & thinking a certaine houre of the day: cause the partie to account from what *Card* hee pleaseth: with this Proviso, that when you see where hee intends to account set 12. to that *number*, so in counting as before, the end of the account shall fall upon the *Card*: which shall denote or shew the *houre* thought upon, which being turned up will give grace to the action, and wonder to those that are ignorant in the cause.

PRO-

PROBLEM. XV.

How to make a dore, or a Gate, which shall open on both sides.

ALL the skill and subtiltie of this, rests in the artificiall disposer of 4 plates of *Iron*, two at the higher end, and two at the lower end of the Gate: so that one side may move upon the hookes or hindges of the *Posts*, and by the other end may be made fast to the *Gate*, and so moving upon these hindges, the *Gate* will open upon one side with the aforesayd plates, or hookes of *Iron*: and by helpe of the other two plates, will open upon the other side.

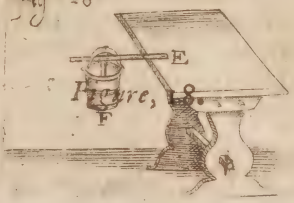
PROBLEM. XVI.

To shew how a Ponderositie, or heavie thing, may be supported upon the end of a staffe (or such like) upon a Table, and nothing holding or touching it.

TAke a paile which hath a handle, and fill it full of *water* (or at pleasure:) then take a staffe or sticke which may not rowle upon the *Table* as *E C*, and place the handle of the *Paile* upon the *staffe*; then place another *staffe*, or sticke

sticke, under the *staffe* CE, which may reach from the bottome of the *Paile* unto the former *staffe* CE, perpendicular wise: which suppose $F.G$, then shall the *Paile* of water hang without falling, for if it fall it must fall perpendicularly, or plumbe wise: and that cannot bee seeing the *staffe* CE, supports it, it being parallel to the *Horizon* and sustained by the *Table*, and it is a thing admirable that if the *staffe* CE, were alone from the table, and that end of the *staffe* which is upon the *Table* were greater and heavier than the other: it would be constrained to hang in that nature.

Fig 18



Figure,

EXAMINATION.

NOw without some experience of this *Probleme*, a man would acknowledge either a possibility or impossibilitie; therefore it is that very touchstone of knowledge in any thing, to discourse first if a thing bee possible in nature, and then if it can bee brought to experience and under sence without seeing it done. At the first, this propoſition seemes to be absurd

absurd, and impossible at the first. Notwithstanding, being supported with two sticks as the figure declareth, it is made facill: for the *Horizontall* line to the edge of the *Table*, is the *Center of motion*; and passeth by the *Center of gravitie*, which necessarily supporteth it.

PROBLEM. XVII.

Of a deceitfull Bowle to play withall.

MAke a hole in one side of the *Bowle*, and cast moulten *Lead* therein, and then make up the hole close, that the *knavery* or deceit be not perceived: you will have pleasure to see, that notwithstanding the *Bowle* is cast directly to the play, how it will turne away side-wise: for that on that part of the *Bowle* which is heavier upon the one side than on the other, it never will goe truly right, if artificially it bee not corrected; which will hazard the *game* to those which know it not: but if it bee knowne that the *leady* side in rowling, be alwayes under or above, it may goe indifferently right; if otherwise, the weight will carry it alwayes side-wise.

PROB-

PROBLEM. XVIII.

To part an Apple into 2. 4. or 8 like parts, without breaking the Rind.

PAsse an *needle* and threed under the *Rind* of the *Apple*; and then round it with diverse turnings, untill you come to the place where you began: then draw out the *thred* gently, and part the *Apple* into as many parts as you thinke convenient: and so the parts may bee taken out betweene the parting of the *Rind*, and the rind remaining alwayes whole.

PROBLEM. XIX.

To finde a number thought upon without asking of any questions, certain operations being done.

BId him adde to the *number* thonght (as admit 15) halfe of it, if it may bee, if not the greatest halfe that exceede the other but by an unite, which is 8; and it makes 23: Secondly, unto this 23. adde the halfe of it if it may bee, if not the greatest halfe *viz.* 12. makes 35. in the meane time; note that if the number thought upon cannot be halfed at the first time as here it cannot: then for it keepe 3. in the memory, if at the second time it will not be

equally halfed, reserve 2. in memory, but if at both times it could not be equally halved, then may you together reserve five in memory: this done, cause him from the last summe, *viz.* 35. subtract the double of the *number* thought, *viz.* 30. rest 5. will him to take the halfe of that if he can, if not, reject 1. and then take the halfe of the rest: which keepe in your memory: then will him to take the halfe againe if he can, if not take one from it, which reserve in your memory, and so perpetually halveing untill 1. remaine: for then marke how many halfes there were taken, for the first halfe account 2, for the second 4, for the third 8, &c. and adde unto those *numbers* the ones which you reserved in memory, so there being 5 remaining in this proposition, there were 2 halfeings: for which last I account 4, but because it could not exactly be halved without rejecting of 1: I adde the 1 therefore to this 4, makes 5, which halfe of summe alwayes multiplyed by 4, makes 20: from which subtract the first 3 and 2, because the halfe could not bee formerly added, leaves 15, the *number* thought upon.

Other

Other examples.

The number thought	12
The halfe of it	6
The ſumme	18
The halfe of it	9
The ſumme of it	27
The double of the number	24
Which taken away, reſts	3

The halfe of it	1
For which account	2
and 1 put to it becauſe the could not bee halfed, makes	3
this multiplied by 4 makes	12

the number thought upon

The number thought	79
The greateſt halfe	40 3
The ſumme	119
The greateſt halfe of which is	60 2
The ſumme of it is	179
The double of 79 is	158
Which taken from it, reſts	21
The leſſer halfe 10. wch halves:	
The halfe of this is 5 which makes	
The half of this is 2 wch is 10	
The half of this is 1, with 10 and 11 is 21.	

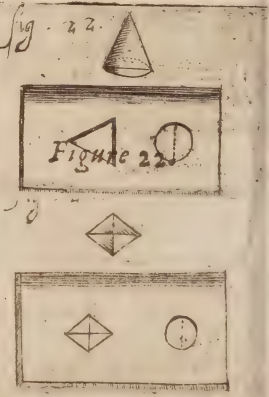
this 21 which is the double of the laſt halfe with the remainder being multiplied by 4 makes 84, from which take the aforeſaid 3 and 2, reſt 79, the number thought upon.

PROBLEM. XX.

How to make an uniforme, & an inflexible body, to paſſe through two ſmall holes of divers formes, as one being circular, & the other ſquare, Quadrangular, and Triangularwiſe, yet ſo that the holes ſhall be exactly filled.

THis *Probleme* is extracted from *Geometricall* obſervations, and ſeemes at the firſt

somewhat obscure, yet that which may be extracted in this nature, will appeare more difficult and admirable. Now in all *Geometricall practices*, the lesser or easier Problemes doe alwayes make way to facilitate the greater: and the aforesaid *Probleme* is thus resolved. Take a *Cone* or round *Pyramedie*, and make a *Circular hole* in some boord, or other hard materiall, which may bee equall to the bases of the *Cone*, and also a *Triangular hole*, one of whose sides may be equall to the *Diamiter* of the *circle*, and the other two sides equall to the length of the *Cone*: Now it is most evident that this *Conicall* or *Pyramidall* body, will fill up the *Circular hole*, and being placed side-wise will fill up the *Triangular hole:* moreover if you cause a body to be turned, which may be like to two *Pyramides* conjoyned, then if a *Circular hole* bee made, whose *Diamiter* is equall to the *diamiter* of the *Cones* conjoyned, and a *Quadrangular hole*, whose sloping sides bee equall to the length of each side of the *Pyramidie*, and the bredth of the hole equall to the *diamiter* of the *Circle*, this conjoyned *Pyramidie* shall exactly fill both the *Circular hole*, and also *Quadrangle hole*.



PROB-

Probleme. XXI.

How with one uniforme body or such like to fill three severall holes: of which the one is round, the other a just square; and the third an ovall forme.

THis propoſition ſeemes more ſubtill than the former, yet it may bee practiſed two wayes: for the firſt, take a *Cilindricall* body as great or little as you pleaſe: Now it is evident that it will fill a *Circular hole*, which is made equall to the baſis of it: if it bee placed downe right, and will alſo fill a long ſquare; whoſe ſides are equall unto the *Diamiter* and length of the *Cylinder*, and according to *Pergeus*, *Archimedes*, &c. in their *Cylindricall* demonſtrations, a true *Ovall* is made when a *Cylinder* is cut ſlopewiſe, therefore if the *Ovall* have bredth equall unto the *Diamiter* of the *Baſis* of the *Cylinder*, & any length whatſoever: the *Cylinder* being put into his owne *Ovall hole* ſhall alſo exactly fill it.

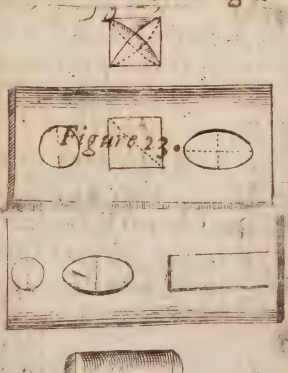


Figure 23.

The ſecond way is thus, make a *Circular hole* in ſome board, and alſo a ſquare hole, the ſide of which *Square* may bee equall to the *Diamiter*

of the *Circle*: and lastly make a hole *Ovall* wise whose bredth may be equall unto the diagonall of the *Square*; then let a *Cylindricall* body bee made, whole *Basis* may be equall unto the *Circle*, and the length equall also to the same: Now being placed downe right shall fall in the *Circle*, and flat-wise will fit the *Square* hole, and being placed sloping-wise will fill the *Ovall*.

EXAMINATION.

YOu may note upon the last two Problemes *farther, that if a* Cone *bee cut* Eclipticke-wise, *it may passe through an* Isocele Triangle *through many* Scalen Triangles, *and through an* Ellipsis; *and if there be a* Cone *cut scalen wise, it will passe through all the former, onely for the* Ellipsis *place a* Circle: *and further if a solid* Colume *be cut* Eclipticke-wise *it may fill a* Circle, *a* Square, *divers* Parallelogrames, *and divers* Ellipsis, *which have different* Diamiters.

Problem XXII.

To finde a number thought upon after another manner, than that which is formerly delivered.

Bid him that he multiply the *number* thought upon, by what *number* he pleaseth, then bid him divide that product by any other *number*, and then multiply that *Quotient* by some other *number*; and that product againe divide by some other, and so often as he will: and here note that he declare or tell you by what *number* he did *multiply* and *devide*. Now in the same time take a *number* at pleasure, and secretly *multiply* and *divide* as often as he did: then bid him *devide* the last *number* by that which hee thought upon. In like manner doe yours privately, then will the *Quotient* of your devisor be the same with his, a thing which seemes admirable to those which are ignorant of the cause. Now to have the *number* thought upon without seemeing to know the last *Quotient*, bid him adde the *number* thought upon to it, and aske him how much it makes: then subtract your *Quotient* from it, there will remaine the *number* thought upon. For example, suppose the *number* thought upon were 5, *multiply* it by 4 makes 20: this divided by 2, the *Quotient* makes 10, which *multiplyed* by 6 makes 60, and divided by 4 makes 15: in the same time admit you thinke upon 4, which *multiplyed* by 4 makes 16, this *divided* by 2 makes 8, which

multiplyed by 6 makes 48, and *divided* by 4 makes 12; then *divide* 15 by the *number* thought which was 5, the *Quotient* is 3; *divide* also 12 by the *number* you tooke, *viz.* 4, the *Quotient* is also 3 as was declared; therefore if the *Quotient* 3 bee added unto the *number* thought *viz* 5, it makes 8, which being known the number thought upon is also knowne.

Problem. XXIII.

To finde out many numbers that sundry persons, or one man hath thought upon.

If the multitude of *numbers* thought upon be odde, as three *numbers*, five *numbers*, seaven &c. as for example let 5 *numbers* thought upon be these, 2, 3, 4, 5, 6. Bid him declare the sum of the first and second, which will be 5; the second and third which makes 7, the third and fourth which makes 9, the fourth and fifth which makes 11, and so alwayes adding the two next together; aske him how much the first and last makes together, which is 8: then take these summes and place them in order, and adde all these together which were in the odde places: that is the first, third, and fifth, *viz.* 5. 9. 8, makes 22. In like manner adde all these *numbers* together which are in the even places, that is in the second and fourth places, *viz.* 7 and 11 makes 18, subtract this from the former 22, then there will remaine the double of the first

first *number* thought upon, *viz.* 4, which knowne the rest is easily knowne: seeing you know the summe of the first and second; but if the multitude of *numbers* bee even as these sixe *numbers*, viz. 2, 3, 4, 5, 6, 7, cause the partie to declare the summe of each two, by antecedent and consequent, and also the summe of the second and last which will bee 5, 7, 9, 11, 13, 10, then adde the odde places together, except the first that is 9, and 13, makes 22; adde also the even places together, that is 7, 11, 10, which makes 28; subtract the one from the other, there shall remaine the double of the second *number* thought upon, which knowne all the rest are knowne.

Problem. XXIIII.

How is it that a man in one and the same time, may have his head upward, and his feet upward, being in one and the same place.

THe answere is very facill, for to bee so he must be supposed to be in the *center* of the *earth*: for as the heavens is above on every side, *Cœlum undique sursum*, all that which lookes to the heavens being distant from the *center* is upward; and it is in this sense that *Maurolycus* in his *Cosmographie*, and first dialogue, reported of one that thought hee was led by one of the *Muses* to hell, where hee saw *Lucifer* sitting

in

in the middle of the *world*, and in the *center* of the *earth* as in a Throne: having his *head* and *feete* upward.

PROBLEM. XXV.

Of a Ladder by which two men ascending at one time; the more they ascend the more they shall be asunder, notwithstanding one being as high as another.

THis is most evident, that if there were a *Ladder* halfe on this side of the *Center* of the *earth*, and the other halfe on the other side: and that two at the *Center* of the *world* at one instant, being to ascend the one towards us, and the other towards our *Antipodes*, they should in ascending goe farther and farther, one from another; notwithstanding both of them being of like height.

PROBLEM. XXVI.

How it is that a man having but a Rode or Pole of land, doth bragge that he may in a right line passe from place to place above 3000 miles.

THe opening of this is easie, forasmuch as he that possesseth a *Rode* of *ground* possesseth

seth not only the exterior surface of the *earth*, but is master also of that which extends even to the *center* of the earth, and in this wise all *heritages* and *possessions* are as so many *Pyramides*, whose summets or points meete in the *center* of the *earth*, and the *basis* of them are nothing else but each mans *possession, field*, or visible quantitie; and therefore if there were made or imagined so to be made, a descent to goe to the bottome of the heritage, which would reach to the *center* of the *earth*; it would bee above 3000 miles in a right line as before.

PROBLEM. XXVII.

How it is that a man standing upright, and looking which way he will, he looketh true North or South.

THis happeneth that if the partie be under either of the *Poles*, for if he be under the *North pole*, then looking any way hee looketh *South*, because all the *Meridians* concurre in the *Poles* of the world, and if he be under the *South pole*, hee lookes directly *North* by the same reason.

PROB-

Problem. XXVIII.

To tell any one what number remaines after certaine operations being ended, without asking any question.

Bid him to thinke upon a *number*, and will him to multiply it by what *number* you thinke convenient: and to the product bid him adde what *number* you pleaſe, provided that ſecretly you conſider, that it may be *divided* by that which *multiplied*, and then let him divide the ſum by the *number* which he firſt *multiplied* by, and ſubtract from this *Quotient* the *number* thought upon: In the ſame time *divide* apart the *number* which was added by that which *multiplied*, ſo then your *Quotient* ſhall bee equall to his remainder, wherefore without asking him any thing, you ſhall tell him what did remaine, which will ſeeme ſtrange to him that knoweth not the cauſe: for example, ſuppoſe he thought 7, which *multiplied* by 5 makes 35, to which adde 10, makes 45, which *divided* by 5 yeeldes 9; from which if you take away one the *number* thought, (becauſe the *Multiplier divided* by the *diviſor* gives the *Quotient* 1,) the reſt will be 2, which will be alſo proved, if 10 the *number* which was added, were *divided* by 5, *viz.* 2.

PROBLEM. XXIX.

Of the play with two severall things.

IT is a pleasure to see and consider how the science of *numbers* doth furnish us, not onely with sports, to recreate the spirits, but also bring us to the knowledge of admirable things, as shall in some measure bee shewen in this ensuing progression. In the meane time to produce alwaies some of them: suppose that a man hold divers things in his hand, as *Gould* and *Silver*, and in one hand he held the *Gould*, and in the other hand hee held the *Silver*: to know subtilly, and by way of divination, or artificially in which hand the *Gold* or *Silver* si; attribute to the gould, or suppose it have a certaine prise, & so likewise attribute to the *Silver* another price, conditionally that the one be odd and the other even: as for example, bid him that the *Gould* be valued at 4. *Crownes*, or *shillings*, and the *Silver* at 2 *Crownes* or 3. *Shillings* or any other *number* so that one be odde, and the other even as before: then bid him triple that which is in the right hand, and double that which is in the left hand, and bid him adde these two products together, and aske him if it be even or odde, if it be even then the *Gould* is in the right hand, if odde the *Gould* is in the left hand.

PROB-

PROBLEM. XXX.

Two numbers being propoſed unto two ſeverall parties, to tell which of theſe numbers is taken by each of them.

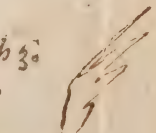
AS for example: admit you had propoſed unto two men whoſe names were *Peter*, and *Iohn*, two *numbers*, or peeces of money, the one even, and the other odde, as 10. and 9. and let the one of them take one of the *numbers*, and the other partie take the other *number*, which they place privatly to themſelves: how artificially, according to the congruitie, and excellency of *numbers*, to finde which of them did take 10. and which 9. without asking any queſtion: and this ſeemes moſt ſubtill, yet delivered howſoever differing little from the former, and is thus performed: Take privately to your ſelfe alſo two *numbers*, the one even and the other odde, as 4. and 3. then bid *Peter* that he double the *number* which he tooke, and doe you privately double alſo your greateſt number; then bid *Iohn* to triple the *number* which he hath, and doe you the like upon your laſt *number*: adde your two products together, and marke if it be even or odde, then bid the two parties put their *numbers* together, and bid them take the halfe of it, which if they cannot doe, then immediatly tell *Peter* hee tooke 10. and *Iohn* 9. becauſe the aggregate of the double of 4. and the triple of 3. makes odde

an

nd such would be the aggregate or summe of he double of *Peters number* and *Iohns number*, f *Peter* had taken 10. if otherwise, then they night have taken halfe, and so *Iohn* should nave taken 10. and *Peter* 9. as suppose *Peter* nad taken 10. the double is 20, and the triple of). the other *number* is 27. which put together makes 47. odde: in like manner the double of your *number* conceived in minde, viz. 4. makes 8. and the triple of the 3. the other *number*, makes 9. which set together makes 17. odde: Now you cannot take the halfe of 17 nor 47. which argueth that *Peter* had the greater *number*, for otherwise the double of 9. is 18. and the triple of 10. is 30. which set together makes 48. the halfe of it may be taken: therefore in such case *Peter* tooke the lesse *number*: and *Iohn* the greater, and this being done cleanly carries much grace with it.

PROBLEM. XXXI.

How to describe a Circle that shall touch 3. Points placed howsoever upon a plaine, if they be not in a right line.



LEt the three points bee *A. B. C.* put one foot of the *Compasse* upon *A.* and describe an *Arch* of a *Circle* at pleasure: and placed at *B.* crosse that *Arke* in the two points *E.* and *F.* and placed in *C.* crosse the *Arke* in *G.* and *H.* then lay a ruler upon *G. H.* and draw a line, and

place

place a *Ruler* upon *E.* and *F.* cut the other line in *K.* so *K.* is the Center of the *Circumference* of a *Circle*, which will passe by the said three points *A. B. C.* or it may bee inverted having a *Circle* drawne, to finde the *Center* of that *Circle*. Make 3. points in the *circumference*, and then use the same way: so shall you have the *Center* a thing most facill, to every practitioner in the principles of *Geometrie*.

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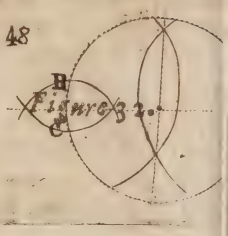


Figure 32.

PROBLEM. XXXII.

How to change a Circle into a square forme.

MAke a *Circle* upon pastboard or other materiall, as the *Circle A. C. D. E.* of which *A.* is the *Center*; then cut it into 4. quarters and dispose them so, that *A.* at the center of the *Circle* may alwaies be at the *Angle* of the *square*, and so the foure quarters of the *Circle*

Circle being placed so, it will make a perfect *square*, whose side *A. A.* is equall to the *diamiter B. D.* Now here is to bee noted that the *square* is greater than the *Circle* by the vacuity in the middle, *viz. M.*

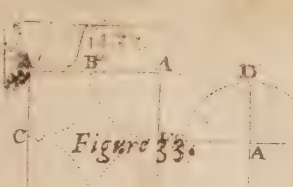


Figure 33.

PROBLEM. XXXIII.

With one and the same compasses, and at one and the same extent, or opening, how to describe many Circles concentricall, that is, greater or lesser one than another.

IT is not without cause that many admire how this proposition is to bee resolved; yea in the judgement of some it is thought impossible: who consider not the industrie of an ingenious *Geometritian*, who makes it possible, and that most facill, sundry wayes; for in the first place if you make a *Circle* upon a fine plaine, and upon the Center of that *Circle*, a small stegge of wood be placed, to bee raised up and set downe at pleasure by helpe of a small hole made in the *Center*, then with the same opening of the *Compasses*, you may describe *Cir-*

cles Concentricall: that is, one greater or lesser than another: for the higher the *Center* is lifted up, the lesser the *Circle* will be. Secondly, the compasse being at that extent upon a *Gibus* body, a *Circle* may bee described, which will be lesse than the former, upon a plaine, and more artificially upon a *Globe*, or round *bowle:* and this againe is most obvious upon a round *Pyramide*, placing the *Compasses* upon the top of it which will be farre lesse than any of the former; and this is demonstrated by the 20. Pro. of the first of *Euclids* for the *Diamiter E.D.* is lesse than the line *A D.* & *A E.* taken together, and the lines *A D* *A E.* being equall to the *Diamiter B C.* because of the same distance or extent of opening the *Compasses*, it followes that the *Diamiter E D* and all his *Circles* together is much lesse than the *Diamiter* and the *Circle B C.* which was to be performed.

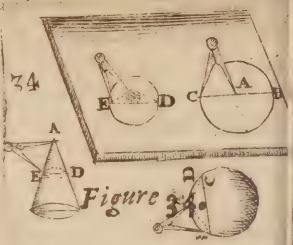


Figure 34.

PROBLEM. XXXIIII.

Any numbers under 10. being thought upon, to finde what numbers they were.

Et the first *number* be doubled, and unto it adde 5. and *multiplyed* that summe by 5. and nto it adde 10. and the next *number* thought pon; *multiplye* this same againe by 10. nd adde unto it the next *number*, and so proeede: now if he declare the last summe; marke he thought but upon one figure, for then subract onely 35. from it, and the first figure in he place of tens is the *number* thought upon: he thought upon two figures, then subtract 5. also, and the 2. also the said 35. from his last imme, and the two figures which remaines are he *number* thought upon: if he thought upon nree figures, then subtract 350. and then the rst 3. figures are the *numbers* thought upon, c. so if one thought upon these *numbers* 5.7. ,6. double the first, makes 10. to which adde 5. nakes 15. this *multiplyed* by 5. makes 75. to vhich adde 10. makes 85. to this adde the next *umber*, viz. 7. makes 92. this *multiplyed* by 10. nakes 920. to which adde the next *number*, viz. .makes 929. which *multiplyed* by 10. makes 290. to which adde 6. makes 9296. from vhich subtract 3500. resteth 5796. the foure *umbers* thought upon. Now because the two ast figures are like the two *numbers* thought

upon: to conceale this bid him take the half of it, or put first 12. or any other *number* to it and then it will not be so open.

PROBLEM. XXXV.

Of the Play with the Ring.

AMongst a company of 9. or 10. persons one of them having a *Ring*, or such like to finde out in which hand: upon which *finger* joynt it is; this will cause great astonishment to ignorant spirits, which will make them beleeve that he that doth it workes by *magicke* or *witchcraft*: But in effect it is nothing else but an nimble act of *Arithmeticke*, founded upon the precedent *Probleme*: for first it is supposed that the persons stand or sit in order that one is first, the next second, &c. likewise there must be imagined that of these two hands the one is first and the other second: and also of the five *fingers* the one is first, the next is second, and lastly of the *joynts*, the one is as 1. the other as 1. the other is as 2. the other as 3. &c. from whence it appeares that in performing this *Play* there is nothing else to be done than to thinke 4. *numbers*: for example if the forth person had the *Ring* in his left hand: and upon the fift *finger* and third *joynt*, and I would divine and finde it out thus: I would proceed as in the 35. *Probleme*: in causing him to double the first *number*: that is, the number of per-

sons

ons, which was 4. and it makes 8. to which ad
. makes 13. this *multiplyed* by 5. makes 65. put
0. to it, makes 75. unto this put 2. for the *num-*
er belonging to the left *hand*, and so it makes
7. which *multiplyed* by 10. makes 770. to this
dde the *number* of the *fingers* upon which the
ing is, viz. 5. makes 775. this *multiplyed* by
0 makes 7750. to which adde the *number* for
he *joynt* upon which the *Ring* is viz. the third
ynt, makes 7753. to which cause him to adde
4. or some other *number*, to conceale it the
etter: and it makes 7767. which being declared unto you, subtract 3514. and there will remaine 4. 2. 5. 3. which figures in order declares
he whole mystery of that which is to bee
nowne, 4. signifieth forth person, 2. the left
and, 5. the fifth finger, and 3. the third *joynt*
f that *finger*.

Problem. XXXVI.

The Play of 3 4. or more Dice.

That which is said of the two precedent *Problemes* may be applyed to this of *Dice* (and many other particular things) to
hde what *number* appeare upon each *Dice*
ing cast be some one, for the points that are
on any side of a *Dice* are alwayes lesse than
. and the points of each side of a *Dice* may be
ken for a *number* thought upon: therefore
e *Rule* will be as the former: As for example,

one having throwne three *Dice* & you would declare the *numbers* of each one, or how much they make together, bid him double the points of one of the *Dice*, to which bid him adde 5. then multiply that by 5. and to it adde 10. and to the ſumme bid him adde the number of the ſecond *Dice*: and multiplie that by 10. laſtly, to this bid him adde the *number* of the laſt *Dice*, and then let him declare the whole *number*: then if from it you ſubtract 350. there will remaine the number of the three *Dice* throwne.

PROBLEM. XXXVII.

How to make water in a Glaſſe ſeeme to boyle and ſparkle.

TAke a *Glaſſe* neare full of *water* or other *liquor*; and ſetting one hand upon the foote of it, to hould it faſt: turne ſlightly one of the *fingers* of your other hand upon the brimme, or edge of the *Glaſſe*; having before privatly wet your *finger*: and ſo paſſing ſoftly on with your *finger* in preſſing a little for then firſt the *Glaſſe* will begin to make a noyſe: ſecondly the parts of the *Glaſſe* will ſenſibly appeare to tremble, with notable *rarification* and *condenſation*: thirdly the *water* will ſhake, ſeeme to boyle: fourthly it will caſt it ſelfe out of the *Glaſſe*, and leape out by ſmall drops, with great aſtoniſhment to the ſtander by; if they be ignorant of the cauſe of it, which

is onely in the *Rarifaction* of the parts of the *Glasse*: occasioned by the motion and pressure of the *finger*.

EXAMINATION.

THe cause of this, is not in the rarifaction of the parts of the Glasse, *but it is rather in the quicke locall motion of the finger, for reason sheweth us that by how much a* Body *draweth nearer to a qualitie, the lesse is it subject or capable of another which is contrary unto it: now condensation, and rarifaction are contrary qualities and in this* Probleme *there is three bodies considered, the* glasse, *the* water, *and the* ayre; *now it is evident that the* Glasse *being the most solid, and impenitrable* Body, *is lesse subject, and capable of rarifaction than the* water, *the* water *is lesse subject than the* ayre, *and if there be any rarifaction, it is rather considerable in the* ayre *than in the* water, *which is inscribed by the* Glasse, *and above the* water, *and rather in the* water *than in the* Glasse: *the agitation, or the trembling of the parts of the* Glasse *to the sence appeares not: for it is a continued body; if in part why then not in the whole; and that the* water *turnes in the* Glasse *this appeares not, but onely the upper contiguous parts of the* water: *that at the bottome being lesse subject to this agitation, and it is most certaine that by how much*

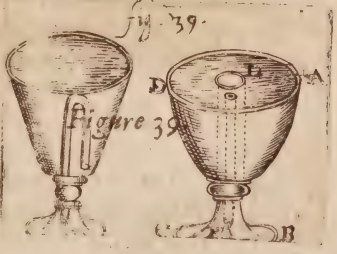
quicker the circular *motion of the finger upon the edge of the* Glasse *is, by so much the more shall the* Ayre *be agitated, and so the water shall receive some apparant affection more or lesse from it, according to that motion: as wee see from the quicknesse of winde uppon the Sea, or calme thereof, that there is a great or lesser agitation in the* water; *and for further examination, we leave it to the search of these which are curious.*

PROBLEME XXXVIII.

Of a fine vessell which holds wine or water, being cast into it at a certaine height, but being filled higher, it will runne out of its owne accord.

LEt there be a *vessell A. B. C. D.* in the middle of which place a *Pipe*; whose ends both above at *E*, and below at the bottome of the *vessell* as at *F*, are open; let the end *E.* be somewhat lower than the brimme of the *Glasse*: about this *Pipe* place another *Pipe* as *H. L*, which mounts a little above *E*, and let it most diligently be closed at *H.* that no *Aire* enter in thereby, and this *Pipe* at the bottome may have a small hole to give passage unto the *water*: then powre in *water* or *wine*, and as long as it mounts not above *E*, it is safe; but if you powre in the *water* so that it mount above it, farewell all: for it will not cease untill it be all gone out

out: the ſame may be done in diſpoſing any crooked *Pipe* in a *veſſell* in the manner of a *faucet* or *funnell*, as in the figure *H*: for fill it under *H.* at pleaſure, and all will goe well; but if you fill it unto *H.* you will ſee fine ſport, for then all the *veſſell* will bee empty incontinent, and the ſubtiltie of this will ſeeme more admirable, if you conceale the *Pipe* by a *Bird, Serpent*, or ſuch like, in the middle of the *Glaſſe*. Now the reaſon of this is not difficult to theſe which know the nature of a *Cocke* or *Faucet*; for it is a bowed *Pipe* one end of which is put into the water or liquor, and ſucking at the other end untill the *Pipe* be full, then will it runne of it ſelfe; and it is a fine ſecret in nature to ſee, that if the end of the *Pipe* which is out of the *water* be lower than the *water*, it will runne out without ceaſing: but if the mouth of the *Pipe* bee higher than the *water* or levell with it, it will not runne, although the *Pipe* which is without be many times bigger than that which is in the *water*: for it is the property of *water* to keepe alwayes exactly levell.



EXAMINA-

EXAMINATION.

HEre is to be noted that if the face *of the* water *without be in one and the same plain, with that which is within, though the outtermost* Pipe *bee ten times greater than that which is within: the* water *naturally will not runne, but if the plaine of the* water *without be any part lower than that which is within, it will freely runne: and here may be noted further that if the mouth of the* Pipe *which is full of* water, *doth but onely touch the superficies of the* water *within, although the other end of the* Pipe *without be much lower than that within, the* water *it will not run at all: which contradicts the first ground; hence we gather that the pressure or ponderositie of the* water *within, is the cause of running in some respect.*

PROBLEM. XXXIX.

Of a Glasse very pleasant.

SOmetimes there are *Glasses* which are made of a double fashion, as if one *Glasse* were within another, so that they seeme but one, but there is a little space betweene them. Now powre *wine* or other liquor betweene the two edges

edges by helpe of a *Tunnell*, into a little hole left to this end: so will there appeare two fine deluſions or fallacies; for though there be not a droppe of *wine* within the hollow of the *Glaſſe*, it will ſeeme to theſe which behold it that it is an ordinary *Glaſſe* full of *wine*, and that eſpecially to theſe which are ſidewiſe of it; and if any one moove it, it will much confirme it, becauſe of the motion of the *wine:* but that which will give moſt delight, is that if any one ſhall take the *Glaſſe*, and putting it to his mouth ſhall thinke to drinke the *wine*; inſtead of which hee ſhall ſuppe the *aire:* and ſo will cauſe laughter to theſe that ſtand by: who being deceived, will hold the *Glaſſe* to the light; and thereby conſidering that the rayes or beames of the light are not reflected to the eye, as they would bee if there were a liquid ſubſtance in the *Glaſſe:* hence they have an aſſured proofe to conclude, that the hollow of the *Glaſſe* is totally empty.

Problem. XL.

If any one ſhould hold in each hand, as many peeces of money as in the other, how to finde how much there is.

Bid him that holdes the *money* that hee put out of one hand into the other what *number* you thinke convenient: (provided that it may be done,) this done, bid him that out of the *hand* that he put the other *number* into, that he take

take out of it as many as remaine in the other *hand*, and put it into that *hand*: for then be assured that in the *hand* which was put the first taking away: there will be found just the double of the *number* taken away at the first. *Example*, admit there were in each *hand* 12 *Shillings* or *Counters*, and that out of the right *hand* you bid him take 7 and put it into the left: and then put into the right hand from the left as many as doth remaine in the right, which is 5: so there will bee in the left *hand* 14, which is the double of the *number* taken out of the right *hand*, to wit 7: then by some of the rules before delivered, itis easie to finde how much is in the right *hand*, *viz.* 10.

PROBLEM. XLI.

Many Dice being cast, how artificially to discover the number of the points that may arise.

SVppose any one had cast three *Dice* secretly, bid him that he adde the points that were upmost together: then putting one of the *Dice* apart, unto the former summe adde the points which are under the other two, then bid him throw these two *Dice*, and marke how many points a paire are upwards, which adde unto the former summe: then put one of these *Dice* away not changing the side, marke the points

which

which are under the other *Dice*, and adde it to the former summe: lastly throw that one *Dice*, and whatsoever appeares upward adde it unto the former summe; and let the *Dice* remaine thus: this done, comming to the *Table*, note what points doth appeare upward upon the three *Dice* which adde privately together, and unto it adde 21 or 3 times 7: so this *Addition* or summe shall be equall to the summe which the party privately made of all the operations which hee formerly made. As if hee should throw three *Dice*, & there should appeare upward 5,3,2. the sum of them is 10: & setting one of them aparte as 5. unto 10, adde the points which are under 3 and 2, which is 4 and 5; and it makes 19: then casting these two *Dice* suppose there should appeare 4 and 1, this added unto 9 makes 24: and setting one of these two *Dice* aparte as the 4. unto the former 24, I adde the number of points which is under the other *Dice*, *viz.* under 1, that is 6, which makes 30. Last of all I throw that one *Dice*, and suppose there did appeare 2, which I adde to the former 30, and it makes 32: then leaving the 3 *Dice* thus, the points which are upward will be these, 5, 4, 2, unto which adde secretly 21, (as before was said) so have you 32 the same *number* which he had: and in the same manner you may practice with 4, 5, 6, or many *Dice* or other *bodies*, observing onely that you must adde the points opposite of the *Dice*: for upon which depends the whole demonstration or secret of the play; for alwayes that which is above and underneath

neath makes 7: but if it make another *number*, then must you adde as often that *number*.

PROBLEM. XLII.

Two mettals as Gold and Silver, or of other kind weighing alike, being privately placed into two like Boxes, to finde which of them the Gold or Silver is in.

IT is said that an *Emperor* was requested by one of his *servants* after he had long time remained with him, to assigne him some reward: to which after few dayes the *Emperour* condescended, and caused him to come into his *Treasury*, where he had prepared two *Boxes*, one full of *Gold*, and the other full of *Lead*, both weighing, and of forme and *magnitude* alike: and bid him chuse which he would have. Now many thinke that in this *Probleme* one must be guided onely by fortune in this choise, and it is that which most makes a man happy in such a choise: but the want of knowledge causeth them so to judge which knoweth not otherwise. A *Mathematician* accounts it an easie proposition and will infallibly chuse the chest of *gold*, and leave the chest of *lead*, without either breaking, or opening any of the chests, and not goe by chance and fortune: for if he may bee permitted to weigh those chests first in the *aire*, then in the *water*: it is a thing cleare

by

by the proportion of *mettalls*, and according to the principles of *Archimedes*, that the *Gold* shall be lesse weighty by his eighteenth part, and the *lead* by his eleventh part; wherefore there may bee gathered in which is the *Gold*, and in which is the *lead*.

Figure 44.

But because that this experiment in water hath diverse accedents, and therefore subject to a caution; and namely because the matter of the cheſt, mettle, or other things may hinder.

Behold here a more subtill and certaine invention to finde and discover it out without weighing it in the water: Now experience and reason sheweth us that two like bodies or *magnitudes* of equall weight, and of divers mettalls, are not of equall quantity: & seeing that *gold* is the heavieſt of all mettalls, it will occupie lesse roome or place; from which will follow that the like weight of *lead* in the same forme, will occupie or take up more roome or place. Now let there be therfore presented 2 *globes* or *cheſts* of *wood* or other matter alike, and equall one to the other, in one of which in the middle there is another *Globe* or body of *lead* weighing 12 pound (as *C*,) and in the other a *Globe* or like body of *gold* weighing 12 pound (as *B*.) Now

it

it is ſuppoſed that the wooden *globes* or *cheſts* are of equall weight, forme, and magnitude: and to diſcover in which the *gold* or *lead* is in, take a broade paire of *Compaſſes* and clip one of the *coffers* or *globes* ſomewhat from the middle as at *D*; then fixe in the *cheſt* or *globe* a ſmall peece of *iron* between the feet of the *compaſſes*, as *E K*, at the end of which hang a weight *G* ſo that the other end may be counterpoyſed, and hang *in æquilibro*: & doe the like to the other *cheſt* or *globe*. Now if that the other *cheſt* or *globe* being clipſed in like diſtant from the end, and hanging at the other end the ſame weight *G*. there be found no difference: then clipſe them nearer towards the middle, that ſo the points of the *Compaſſe* may bee againſt ſome of the mettell which is incloſed: or juſt againſt the extremitie of the *gold* as in *D*, and ſuppoſe it hang thus in *æquilibrio*; it is certaine that in the other *coffer* is the *lead*; for the points of the *Compaſſes* being advanced as much as before, as at *F*. which takes up a part of the *lead*, (becauſe it occupies a greater place than the *gold*) therefore that ſhall helpe the weight *G* to weigh, and ſo will not hang in *æquilibrio* except *G* be placed neare to *F*: hence we may conclude that there is the *lead*; and in the other *cheſt* or *globe* there is the *gold*.

EXAMINA-

EXAMINATION.

IF *the two* Boxes *being of equall* magnitude *weighed in the* aire *be found to bee of equall weight, they shall necessarily take up like place in the* water, *& therefore weigh also one as much as another: hence there is no possibilitie to finde the inequallitie of the mettells which are incloſed in theſe* Boxes *in the water: the intention of* Archimedes *was not upon contrary mettells incloſed in equall* Boxes, *but conſiſted of comparing mettels, ſimple in the* water *one with another: therefore the inference is falſe and abſurd.*

PROBLEM. XLIII.

Two Globes of diverſe mettles, (as one gold and the other copper) yet of equall weight being put into a boxe as B. G. to finde in which end the gold or copper is.

THis is diſcovered by the changing of the places of the two *Bowles* or *Globes* having the ſame counterpoyſe *H.* to bee houng at the other ſide as in *N*, and if the Gould which is the leſſer *Globe* were before the neareſt to the handle *D. E.* having now changed his place will bee fartheſt from the handle *D. E.* as in *K*.

therefore the Center of gravitie of the two *Globes* taken together, shall bee farther separate from the midle of the handle (under which is the Center of gravitie of the *Box*) than it was before, and seeing that the handle is alwayes in the midle of the *box*, the waight *N* must bee augmented, to keepe it in æquilibria: and by this way one may know, that if at the second time, the counterpoise bee too light, it is signe that the *Gould* is fartheſt off the handle, as at the firſt triall it was neareſt.

fig. 45.

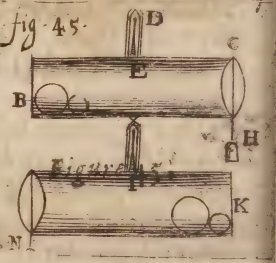


Figure 45.

PROBLEM. XLIIII.

How to repreſent diverſe ſorts of Rainebowes here below.

THe *Rainebow* is a thing admirable in the world, which raviſheth often the eyes and ſpirits of men in conſideration of his rich intermingled colours which are ſeene under the cloudes, ſeeming as the gliſtering of the *ſtarres*, pretious ſtones, & ornaments of the moſt beautious flowers: ſome part of it as the reſplendant *ſtars*, or as a *roſe*, or burning *cole* of fire: in it one may

may see dies of sundry sorts, the *violet*, the *blew*, the *orion*, the *saphir*, the *jacint*, and the *emeraud* colours, as a lively plant placed in a greene soyle: and as a most rich treasure of nature, it is a high worke of the *Sunne* who casteth his rayes or beames as a curious Painter drawes strokes with his pensell, and placeth his colours in an exquisite situation; and *Salomon* saith, *Eccles.* 43. it is a chiefe and principall worke of *God*. Notwithstanding there is left to industrie how to represent it from above, here below, though not in perfection yet in part, with the same intermixture of colours that is above.

Have you not seene how by *Oares* of a *Boate* it doth exceeding quickly glide upon the *water* with a pleasant grace? *Aristotle* sayes that it coloureth the *water* and makes a thousand atomes, upon which the beames of the *Sunne* reflecting makes a kinde of coloured *Rainebow*: or may we not see in *houses* or *gardens* of pleasure artificiall *fountaines*, which powre forth their droppie streames of *water*, that being betweene the *Sunne* and the fountaine, there will be presented as a continuall *Rainebow*? But not to goe farther, I will shew you how you may doe it at your doore, by a fine and facill experiment.

Take *water* in your mouth, and turne your backe to the *Sunne*, and your face against some obscure place, then blow out the *water* which is in your mouth, that it may bee sprinkled in small drops and vapours: you shall see these

atomes vapours in the beames of the *Sunne* to turne into a faire *Rabinebow*, but all the griefe is that it lasteth not but soone is vanished.

But to have one more stable and permanent in his colours, take a *Glasse* full of *water* and expose it to the *Sunne*, so that the rayes that passe through strike upon a shadowed place, you will have pleasure to see the fine forme of a *Rainebow* by this reflexion. Or take *Trigonall Glasse* or *Cristall Glasse* of diverse Angles, and looke through it, or let the beames of the *Sunne* passe through it, or with a candle let the appearances be received upon a shadowed place: you will have the same contentment.

Problem. XLV.

How that if all the Powder in the world were inclosed within a bowle of paper or glasse, and being fired on all parts, it could not breake that bowle.

IF the *bowle* and the *powder* be uniforme in all his parts, thē by that means the *powder* would presse and move equally on each side, in which there is no possibilitie whereby it ought to begin by one side more than another. Now it is impossible that the *bowle* should bee broken in all his parts: for they are infinite.

Of like finenes or subtiltie may it be that a *bowle* of *iron* falling from a high place upon a plaine pavement of thin *Glasse*, it were impos-

sible

sible any wise to breake it; if the *bowle* were perfectly round, and the *Glasse* flat and uniforme in all his parts: for the *bowle* would touch the *Glasse* but in one point, which is in the middle of infinite of parts which is about it: neither is there any cause why it ought more on one side than on another, seeing that it may not be done with all his sides together; it may bee concluded as speaking naturally, that such a *bowle* falling upon such a *glasse* will not break it. But this matter is meere *Metaphysicall*, and all the workemen in the world cannot ever with all their industrie make a *bowle* perfectly round, or a *Glasse* uniforme.

Problem. XLVI.

To finde a number which being divided by 2 *there will remaine* 1, *being divided by* 3, *there will remaine* 1; *and so likewise being divided by* 4, 5, *or* 6. *there would still remaine* 1: *but being divided by* 7, *there will remaine nothing.*

In many *Authors* of *Arithmeticke* this *Probleme* is thus proposed: A *woman* carrying *egges* to market in a *basket*, mett an unruly fellow who broake them; who was by order made to pay for them: and she being demanded what number she had, shee could not tell: but she re-

membred that counting them by 2, & 2; there remained 1: likewise by 3 and 3, by 4 and 4, by 5 and 5, by 6 and 6; there still remained 1: but when she counted them by 7 and 7, there remained nothing: Now how may the number of *egges* be discovered?

Finde a number which may exactly be measured by 7, and being measured by 2, 3, 4, 5, and 6; there will still remaine a unity: multiply these *numbers* together, makes 702, to which adde 1; so have you the *number*, *viz.* 721: in like manner 301 will be measured by 2, 3, 4, 5, 6; so that 1 remaines: but being measured by 7, nothing will remaine; to which continually adde 220, and you have other *numbers* which will doe the same: hence it is doubtfull what *number* shee had, therefore not to faile it must be knowne whether they did exceed 400, 800, &c. in which it may bee conjectured that it could not exceed 4 or 5 hundred, seeing a *man* or *woman* could not carry 7 or 8 hundred *egges*; therefore the *number* was the former 301. which shee had in her *basket*: which being counted by 2 and 2, there will remaine 1, by 3 and 3, &c. but counted by 7 and 7, there will

PROB-

PROBLEME XLVII.

One had a certaine number of crownes, and counting them by 2 and 2, there rested 1: counting them by 3 and 3, there rested 2: counting them by 4 and 4, there rested 3: counting them by 5 and 5, there rested 4: counting them by 6 and 6, there rested 5: but counting them by 7 and 7, there remained nothing: how many crownes might hee have.

THis *Question* hath some affinitie to the precedent, and the resolution is almost in the same manner: for here there must be found a *number*, which multiplied by 7, and then divided by 2, 3, 4, 5, 6; there may alwayes remaine a *number* lesse by 1 than the divisor: Now the first *number* which arives in this nature is 119, unto which if 420 be added, makes 539, which also will doe the same: and so by adding 420, you may have other *numbers* to resolve this proposition.

PROBLEM. XLVIII.

How many sorts of weights in the least manner must there be to weigh all sorts of things betweene 1 pound and 10 pound, and so unto 121, and 364 pound.

TO weigh things betweene 1 and 40: take numbers in triple proportion, so that their

ſumme be equall, or ſomewhat greater than 40, as are the numbers 1. 3, 9. 27. I ſay that with 4 ſuch weights, the firſt being of 1 pound, the ſecond being 3 pound, the third being 9 pound, and the fourth being 27: any weight betweene 1 and 40 pound may bee weighed. As admit to weigh 21 pound, put unto the thing that is to be *weighed* the 9 pound *weight*, then in the other *ballance* put 27 pound and 3 pound which doth counterpoiſe 21 pound and 9 pound: and if 20 pound were to be *weighed*, put to it in the *ballance* 9 and 1, and in the other *ballance* put 27 and 3, and ſo of others.

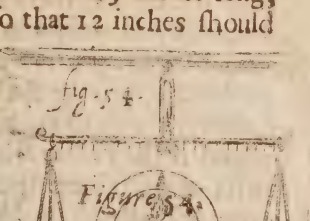
In the ſame manner take thoſe 5 *weights*, 1, 3, 9, 27, 81, you may *weigh* with them betweene 1 pound, and 121 pound: and taking thoſe 6 *weights*, as 1, 3, 9, 27, 81, 243, you may weigh even from 1 pound unto 364 pound: this depends upon the property of continued proportionalls, the latter of which containing twice all the former.

Problem. XLIX.

Of a deceitfull ballance which being empty ſeemes to be juſt, becauſe it hangs in æquilibrio: notwithſtanding putting 12 *pound in one ballance, and* 11 *in the other, it will remaine in æquilibrio.*

ARiſtotle maketh mention of this *ballance* in his mechanicke *Queſtions*, and ſaith that the

the *Merchants* of purpose in his time used them to deceive the world: the subtiltie or craft of which is thus, that one arme of the *ballance* is longer than another, by the same proportion, that one weight is heavier than another: As if the beame were 23 inches long, and the handle placed so that 12 inches should be on one side of it, and 11 inches on the other side: conditionally that the shorter and should be as heavy as the longer, a thing easie to bee done: then afterwards put into the *ballance* two unequall weights in such proportion as the parts of the *beame* have one unto another, which is 12 to 11; but so that the greater be placed in the *ballance* which hangs upon the shorter part of the *beame*, and the lesser weight in the other *ballance:* it is most certaine that the *ballances* will hang in *aquilibrio*, which will seeme most sincere and just; though it bee most deceitfull, abominable, and false.



The reason of this is drawne from the experiments of *Archimedes*, who shewes that two unequall weights will counterpoyse one another, when there is like proportion betweene the parts of the *beame* (that the handle separates)

rates) and the weights themſelves: for in one and the ſame counterpoiſe, by how much it is farther from the Center of the handle, by ſo much it ſeemes heavier; therefore if there be a diverſitie of diſtance that the *ballances* hang from the handle, there muſt neceſſarily bee an inequallity of weight in theſe *ballances* to make them hang in *æquilibrio*, and to diſcover if there be deceite, change the weight into the other *ballance*, for as ſoone as the greater weight is placed in the *ballance* that hangs on the longer parts of the beame: it will weigh downe the other inſtantly.

Problem. L.

To heave or lift up a bottle with a ſtraw.

TAke a *ſtraw* that is not bruiſed, bow it that it make an Angle, and put it into the *bottle* ſo that the greateſt end bee in the necke; then the Reede being put in the bowed part will caſt ſidewiſe, and make an Angle as in the figure may bee ſeene; then may you take the end which is out of the *bottle* in your hand, and heave up the *bottle*: and it is

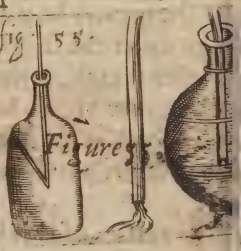


Fig. 55.
Figure 55.

much surer, by how much the Angle is acuter r sharper; and the end which is bowed approacheth to the other perpendicular parts which comes out of the *bottle*.

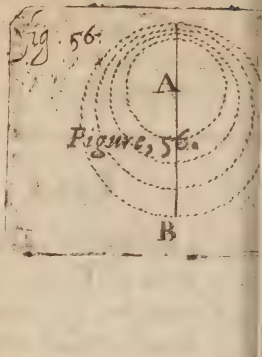
PROBLEM. LI.

low in the middle of a wood or desert, without the sight of the Sunne, Starres, Shaddow or Compasse, to finde out the North or South, or the foure Cardinall points of the world, East, West, &c.

T is the opinion of some, that the *windes* are to be observed in this: if it be hot, the South found by the windes that blow that way, but is observation is uncertaine and subject to uch error: nature will helpe you in some meare to make it more manifest than any of the rmer from a *tree*, thus: cut a small *tree* off even the ground, and marke the many *circles* at is about the sap or pith of the *tree*, which eme nearer together in some part than in oer, which is by reason of the sunnes motion about the *tree*: for that the humiditie of the rts of the *tree* towards the South by the heat the *Sunne* is rarified and caused to extend: d the *Sunne* not giving such heat towards the orth part of the *tree*, the sap is lesser rarified t condensed; by which the *circles* are nearer gether on the North part, than on the South rt: therefore if a line bee drawne from the

widest

wideſt to the narroweſt part of the *circles*, it ſhall ſhew the North and South of the world: Another experiment may bee thus, take a ſmall *needle* ſuch as women worke with: place it gently downe flatwiſe upon ſtill water and it will not ſinke, (which is againſt the generall tenet that iron will n ſwimme) which *needle* will by little and litt turne to the North and South points. But if t *needle* bee great and will not ſwimme, thru it through a ſmall peece of *corke* or ſome ſu like thing, and then it will doe the ſame: f ſuch is the propertie of *iron* when it is plac in *æquilibrio*, it ſtrives to finde out the *Poles* the word, or points of North and South: i manner as the *magnes* doth.



Figure, 56.

EXAMINATION.

HEre is obſervable that the moyſture wh aydeth to the growth of the tree, *is dila and rarified by the* Meridionall heat, *and c tracted by the* Septentrionall cold: *this rarifact workes upon the part of the humour or moyſt*

t

t is more thinne, which doth easily dissipate d evaporate: which evaporation carries a part he salt with it; and because that solidation or densation, so that there is left but a part of nourishment which the heat bakes up and sumes: so contrarily on the other side the con- sation and restrictive quality of the moysture seth lesse evaporation and perdition: and so sequently there remaines more nourishment, ich makes a greater increase on that side than he other side: for as trees *have their growth winter, because their powers, and these of the* th *are shut up: so in the spring when their pow- are open, and when the sappe and moysture is wne by it, there is not such cold on the* North *that it may bee condensed at once: But con- rily to the side which is* South, *the heate may such, that in little time by continuance, this ysture is dissipated greatly: and cold is nothing that which hardneth and contracteth the ysture of the* tree, *and so converteth it into od.*

Problem. LII.

Three persons having taken Counters, Cards, or other things, to finde how much each one hath taken.

Cause the third party to take a *number* which may be divided by 4, & as often as he es 4, let the second party take 7, and the first

firſt take 13, then cauſe them to put them t
together and declare the ſumme of it: whic
ſecretly divide by 3, and the *Quotient* is th
double of the *number* which the third perſo
did take. Or cauſe the third to give unto th
ſecond and firſt, as many as each of them hat
then let the ſecond give unto the firſt and thir
as many as each of them hath: laſtly let th
third give unto the ſecond and firſt, as many
each of them hath; and then aske how muc
one of them hath: (for they will have then
alike,) ſo halfe of that *number* is the *numb*
that the third perſon had at the firſt: whi
knowne all is knowne.

PROBLEME LIII.

*How to make a conſort of muſicke of many par
with one voyce, or one inſtrument onely.*

THis Probleme is reſolved, ſo that a finger
player upon an inſtrument, be neare an *Ec*
which anſwereth his voice or *inſtrument*; and
the *Echo* anſwereth but once at a time, he m
make a *double*; if twice, then a *triple*; if thr
times, then an *harmonie* of foure parts; for
muſt be ſuch a one that is able to exerciſe bo
tune and note as occaſion requires. As when
begins *ut*, before the *Echo* anſwere, he may b
gin *ſol*, and pronounce it in the ſame tune th
the *Echo* anſwereth, by which meanes y
have a fift, agreeable conſort of *muſicke*: th

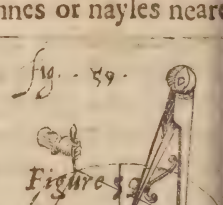
n the same time that the *Echo* followeth, to ound the second note *fol*, hee may sound forth nother *fol* higher or lower to make an eight; he most perfect consort of *musicke*, and so of thers; if he will continue his voyce with the *cho:* and sing alone with two parts. Now experience sheweth this to be true, which often omes to passe in many *Churches*; making one o beleeve that there is many more parts in the usicke of a *Quier*, than in effect truly there is, ecause of the resounding and multiplying of he voyce, and redoubling of the *Quire*.

Problem. LIIII.

To make or describe an Ovall forme, or that which neare resembles unto it, at one turning with a paire of common Compasses.

THere is many fine wayes in *Geometricall practices*, to make an *Ovall figure* or one eare unto it, by severall *centers:* any of which will not touch upon; but shew how it may be one promptly upon one *center* only. In which will say nothing of the *Ovall* forme which peares, when one describeth *circles* with the oints of a common *compasses*, somewhat deepe on a skinne stretched forth hard: which contracting it selfe in some parts of the skinne maeth an *Ovall* forme. But it will more evidentappeare upon a *columne* or *cylinder*: if *paper* be

be placed upon it, then with a paire of *Compaſſes* deſcribe as it were a *circle* upon it, which paper afterwards being extended, will not bee *circular* but *ovall-wiſe:* and a paire of *Compaſſes* may be ſo accommodated that it may be done alſo upon a plain thus. As let the length of the *Ovall* be *H. K*, faſten 2 pinnes or nayles neare the end of that line as *F. G*, and take a threed which is double to the length of *G. H*, or *F. K*: then if you take a *Compaſſe* which may have one foot lower than another, with a ſpring betweene his *legges:* & placing one foot of this *Compaſſe* in the *Center* of the *Ovall*, and guiding the threed by the other foot of the *Compaſſes*, and ſo carrying it about: the ſpring will helpe to deſcribe and draw the *Ovall* forme. But in ſtead of the *Compaſſes* it may be done with ones hand onely, as in the figure may appeare.



PROBLEM. LV.

Of a purſe difficult to be opened.

IT is made to ſhut and open with *rings*: ſi
at each ſide there is a ſtrap or ſtring, as *A*

and *CD*, at the end of which are 2 *rings*, *B* & *D*, and the string *C D* passeth through the *ring B*, so that it may not come out againe; or be parted one from another: and so that the *ring B*, may slide up and downe upon the string *C D*, then over the *purse* there is a peece of *leather E. F. G. H.* which covers the opening of the *purse*, and there is another peece of *leather A. E.* which passeth through many *ringes*: which hath a slitte towards the end *I.* so great, that the string *B. C.* may slide into it: Now all the cunning or craft is how to make fast or to open the *purse*, which consists in making the string *B C.* slide through the side at *I*; therefore bring downe *B.* to *I*, then make the end *I.* passe through the *ring B*: and also *D.* with his string to passe through the slit *I*, so shall the *purse* be fast; and then may the rings be put as before: and it will seeme difficult to discover how it was done. Now to open the *purse*, put through the end *I.* through the *ring B*, and then through the slit *I*; by which you put through the string *D C.* by this way the *purse* will be opened.

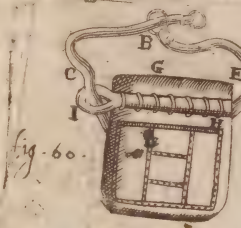


fig. 60.

PROBLEM. LVI.

Whether it is more hard and admirable without Compasses to make a perfect circle, or being made to finde out the Center of it.

IT is said that upon a time past, two *Mathematicians* meete, and they would make tryall of their industry: the one made instantly a perfect *circle* without *Compasses*, and the other immediately pointed out the *center* thereof with the point of a *needle:* now which is the chiefest action: it seemes the first: for to draw the most noblest *figure* upon a plaine *Table* without other helpe than the hand, and the minde, is full of admiration: to finde the *center* is but to finde out only one point, but to draw a round, there must be almost infinite points, equidistant from the *center* or middle: that in conclusion it is both the *circle* and the *center* together. But contrarily it may seeme that to finde the *center* is more difficult, for what attention, vivacitie, and subtiltie must there be in the spirit, in the eye, in the hand, which will chuse the true point amongst a thousand other points? He that makes a *circle* keepes alwayes the same distance, and is guided by a halfe distance to finish the rest; but he that must finde the *center* must in the same time take heed to the parts about it, and choose one onely point which is equall distant from an infinite of other points which are in the *circumference*: which is very difficu

difficult. *Aristotle* confirmes this amongst his moralls, and seemes to explaine the difficultie which is to be found in the middle of vertue; for it may want a thousand wayes and be farre separated from the true *center* of the end of a right mediocritie of a vertuous action: for to doe well it must touch the middle point which is but one, and there must be a true point which respects the end, and thats but one onely. Now to judge which is the most difficults as before is said, either to draw the round or to finde the *center*: the round seemes to be harder than to finde the *center*, because that in finding of it, it is done at once, and hath an equall distant from the whole: But as before to draw a round there is a visible point imagined, about which the *circle* is to bee drawne. I esteeme that it is as difficult therefore if not more, to make the *circle* without a *center*, as to finde the middle or *center* of that *circle*.

Problem. LVI.

Any one having taken 3 Cards, to finde how many points they containe.

THis is to bee exercised upon a full packe of *Cards* of 52, then let one choose any three at pleasure secretly from your sight: and bid him secretly account the points in each *Card*: and will him to take as many *Cards* as will make up 15 to each of the points of his *Cards*;

then will him to give you the reſt of the *Cards*, for 4 of them being rejected, the reſt ſhewes the number of points that his three *Cards* which he tooke at the firſt did containe. As if the 3 *Cards* were 7, 10, and 4; now 7 wants of 15, 8: take 8 *Cards* therefore for your firſt *Card*: the 10 wants of 15. 5, take 5 *Cards* for your ſecond *Card*: laſtly 4 wants of 15, 11, take 11 *Cards* for your third *Card*, and giving him the reſt of the *Cards*, there will be 25; from which take 4, there remaines 21: the number of the three *Cards* taken, *viz.* 7, 10, and 4.

Whoſoever would practiſe this play with 4, 5, 6, or more *Cards*, and that the whole number of *Cards* be more or leſſe than 52; and that the terme be 15, 14, 12, &c. this generall rule enſuing may ſerve: multiply the terme by the number of *Cards* taken at firſt: to the product adde the number of *Cards* taken, then ſubtract this ſumme from the whole number of *Cards*, the remainder is the number which muſt be ſubtracted from the *Cards*, which remaines to make up the game: if there remaine nothing after the *ſubſtraction*, then the number of *card.* remaining doth juſtly ſhew the number of points which were in the *Cards* choſen. If the *ſubſtraction* cannot be made, then *ſubtract* the number of *Cards* from that number, and the remainder added unto the *Cards* that did remaine the ſumme will be the number of points in the *Cards* taken, as if the *Cards* were 7, 10, 5, 8 and the terme given were 12; ſo the firſt wants 5, the ſecond wants 2, the third wants 7, and

th

the fourth wants 4 *Cards*, which taken, the party gives you the reſt of the *Cards*: then ſecretly *multiply* 12 by 4, makes 48; to which adde 4 the number of *Cards* taken, makes 52, from which 52 ſhould bee taken, reſt nothing: therefore according to the direction of the remainder of the *Cards* which are 30, is equall to the points of the foure *Cards* taken, *viz.* 7, 10, 5, 8. Againe let theſe five *Cards* bee ſuppoſed to be taken, 8, 6, 10, 3, 7; their differences to 15, the termes are 7, 9, 5, 12, 8, which number of *Cards* taken, there will remaine but 6 *Cards*: then privatly *multiply* 15 by 5, makes 75, to which adde 5 makes 80, from this take 52 the number of *Cards*, reſt 28, to which adde the remainder of *Cards*, make 34: the ſumme with 8, 6, 10, 3, 7.

PROBLEM. LVII.

Many Cards placed in diverſe rankes, to finde which of theſe Cards any one hath thought.

TAke 15 *Cards* and place them in 3 heapes in ranke-wiſe, 5 in a heape: now ſuppoſe any one had thought one of theſe *Cards* in any one of the heapes, it is eaſie to finde which of the *Cards* it is, and it is done thus: aske him in which of the heapes it is, which place in the middle of the other two: then throw downe the *Cards* by 1 and 1 into three ſeverall heapes in ranke-wiſe, untill all be caſt downe; then aske

him in which of the rankes his *Card* is: which heape place in the middle of the other two heapes alwayes; and this doe foure times at leaſt, ſo in putting the *Cards* altogether, looke upon the *Cards*, or let their backe bee towards you, and throw out the eight *Card*: for that was the *Card* thought upon without faile.

PROBLEM. LVIII.

Many Cards being offered to ſundry perſons, to finde which of thoſe Cards any one thinketh upon.

ADmit there were 4 *perſons*, then take 4 *Cards* and ſhew them to the firſt: bid him think one of them, & put theſe 4 away; then take 4 other *Cards* and ſhew them in like manner to the ſecond perſon, and bid him thinke any one of theſe *Cards*: and ſo doe to the third perſon, and ſo the fourth, &c. Then take the 4 *Cards* of the firſt perſon, and diſpoſe them in 4 rankes: and upon them the 4 *Cards* of the ſecond perſon, upon them alſo theſe of the third perſon, & laſtly upon them theſe of the fourth perſon: then ſhew unto each of theſe parties each of theſe rankes, and aske him if his *Card* be in it which he thought: for infallibly that which the firſt partie thought upon will bee in the firſt ranke, and at the bottome; the *Card* of the ſecond perſon will bee in the ſecond ranke: the *Card* of the third thought upon will be in the third

third ranke, and the fourth mans *Card* will be in the fourth ranke; and so of others: if there bee more persons use the same methode. This may be practised by other things, ranking them by certaine numbers allotted to peeces of money, or such like things.

PROBLEM. LIX.

How to make an instrument to helpe hearing, as Gallileus made to helpe the sight.

THinke not that the *Mathematickes* (which hath furnished us with such admirable helpes for seeing) is wanting for that of hearing: its well knowne that long *trunkes* or *pipes* makes one heare well farre off, and experience shewes us that in certaine places of the *Arcades* in a hollow vault, that a man speaking but softly at one corner thereof, may be audibly understood at the other end: notwithstanding these which are betweene the parties cannot heare him speake at all: And it is a generall principle, that *pipes* doe greatly helpe to strengthen the activitie of naturall causes: we see that fire contracted in a *pipe*, burnes 4. or 5. foot high, which would scarce heat, being in the open aire: the rupture or violence of water issuing out of a *fountaine*, shewes us that water being contracted into a *pipe*, causeth a violence in its passage. The *Glasses* of *Gallileus* makes us

see how useful *pipes* or trunkes are to make the light and species more visible, and proportionable to our eye. It is said that a *Prince* of *Italy* hath a faire *hall*, in which he can with facility heare distinctly the discourses of these which walke in the adjacent *gardens*, which is by certaine vessels and pipes that answere from the *garden* to the *hall*. *Vitruvius* makes mention also of such vessels and pipes, to strengthen the [illegible] and action of *Comedians*: and in these voyce and [illegible] noble personages, the new times amongst many [illegible] helpe the hearing, kinde of *trunkes* are used [illegible] resounding being made of *silver*, *copper*, or other [illegible] and materiall, in funnell-wise putting the widest end to him which speaketh, to the end to contract the voyce, that so by the pipe applyed to the eare it may be more uniforme and lesse in danger to dissipate the voyce, and so consequently more fortified.

Problem. LX.

Of a fine lampe which goes not out, though one carry it in ones pocket: or being rouled upon the ground will still burne.

IT must be observed that the vessell in which the *oyle* is put into, have two pinnes on the sides of it one against another, being included within a *circle*: this *circle* ought to have two other pinnes, to enter into another *circle* of

brasse,

braſſe, or other ſollid matter: laſtly this ſecond *circle* hath two pinnes which may hang within ſome box to containe the whole lampe, in ſuch manner, that there be 6 pinnes in different poſition: Now by the aide of theſe pegges or pinnes, the lampe that is in the middle will bee alwayes well ſcituated according to his Center of gravity, though it bee turned any way: though if you endeavour to turne it upſide downe, it will lie levell; which is pleaſant and admirable to behold to theſe which know not the cauſe: And it is facill from this to make a place to reſt quiet in, though there bee great agitation in the outward parts.

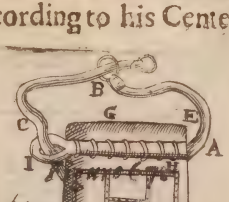


fig. 60.

PROBLEM. LXI.

Any one having thought a Card amongſt many Cards, how artificially to diſcover it out.

TAke any number of *Cards* as 10, 12, &c. and open ſome 4 or 5 to the parties ſight, and bid him thinke one of them, but let him note whether it be the firſt, ſecond, third, &c. then with promptneſſe learne what number of *Cards* you

you had in your hands, and take the other part of the *Cards*, & place the on the top of these you hold in your hand; and having done so, aske him whether his *Card* were the first, second, &c. then before knowing the number of *Cards* that were at the bottome, account backwards untill you come to it: so shall you easily take out the *Card* that he thought upon.

PROBLEM. LXII.

Three women A. B. C. carryed apples to a market to sell, A. had 20, B. 30, and C. 40; they sold as many for a penny, the one as the other: and brought home one as much money as another, how could this be.

THe answere to the *Probleme* is easie, as suppose at the beginning of the market: *A.* sold her *apples* at a penny an *apple*: and sold but 2. which was 2 pence, and so shee had 18 left: but *B.* sold 17. which was 17 pence, and so had 13. left: *C.* sold 32 which was 32 pence, and so had 8 *apples* left: then *A.* said she would not sell her *apples* so

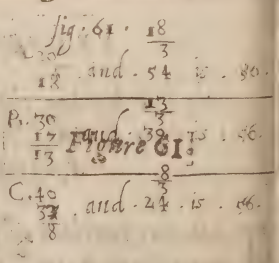


Figure 61.

cheape,

cheape, but would sell them for 3 pence the peece, which shee did: and so her *apples* came to 54 pence, and *B.* having left but 13 *apples* sold them at the same rate which came to 39 pence: and lastly *C.* had but 8 *apples*, which at the same rate came to 24 pence: these summes of money which each others before received come to 56 pence, and so much each one received; and so consequently brought home one as much as another.

Problem. LXIII.

Of the properties of some numbers.

First, any two *numbers* is just the summe of an *number* that have equall distance from the halfe of that *number*: the one augmenting, and the other diminishing, as 7 and 7, of 8 and 6, of 9 and 5, of 10 and 4, of 11 and 3, of 12 and 2, of 13 and 1: as the one is more than the halfe the other is lesse.

Secondly, it is difficult to finde two *numbers* whose summe and product is alike, (that is) if the *numbers* be multiplyed one by another, and added together, will be equall: which two *numbers* are 2 and 2, for to multiply 2 by 2 makes 4, and adding 2 unto 2 makes the same: this property is in no other two whole *numbers*, but in broken *numbers* there are infinite, whose summe and product will bee equall one to another. As *Clavius* shewes upon the 36 *Pro.* of the 9th booke of *Euclide*.

Thirdly,

Thirdly, the *numbers* 5 and 6 are called circular *numbers*, becauſe the circle turnes to the point from whence it begins: ſo theſe *numbers* multiplyed by themſelves, doe end alwayes in 5 and 6, as 5 times 5 makes 25, that againe by 5 makes 125; ſo 6 times 6 makes 36, and that by 6 makes 216, &c.

Fourthly, the *number* 6, is the firſt which *Arithmeticians* call a perfect *number*, that is, whoſe parts are equall unto it, ſo the 6 part of it is 1, the third part is 2, the halfe is 3, which are all his parts: now 1, 2, and 3, is equall to 6. It is wonderfull to conceive that there is ſo few of them, and how rare theſe *numbers* are, ſo of perfect men: for betwixt 1 & 10000000000 *numbers* there is but ten, that is; 6, 28, 486. 8128. 120816. 2096128. 33550336. 5368545 28. 858986 9056, & 137438691328: with this admirable property, that alternately they end all in 6 and 8, & the twentieth perfect *number* is 151115727451553768931328.

Fiftly, the *number* 9 amongſt other priviledges carries with it an excellent property, for take what *number* you will, either in groſſe or in part: the nines of the whole or in its parts rejected, and taken ſimply will be the ſame, as 27 it makes 3 times 9, ſo whether the nines bee rejected of 27, or of the ſumme of 2 and 7, it is all one: ſo if the nines were taken away of 240. it is all one, if the nines were taken away of 2, 4, and 0; for there would remaine 6 in either: and ſo of others.

Sixtly, 11 being *multiplyed* by 2, 4, 5, 6, 7, 8,

8, or 9, will end and begin with like *numbers*; so 11 multiplyed by 5 makes 55: if multiplyed by 8, it makes 88, *&c.*

Seventhly, the *numbers* 220 and 284 being unequall, notwithstanding the parts of the one *number* doth alwayes equallise the other *number*: so the alliquot parts of 220 are 110, 54, 44, 22, 20, 11, 10, 5, 4, 2, 1, which together makes 284: the alliquot parts of 284 are 142, 71, 4, 2, 1, which together makes 220, a thing rare and admirable, and difficult to finde in other *numbers*.

Eightly, the *numbers* 3, 4, 5, (found out by *Pythagoras*) have an excellent property in making of rectangle Triangles: upon which the 47 *Pro:* of the first booke of *Euclide*, was grounded, that the *square* of the *Hypotenusæ* in any such *Triangle*, is equall to the *square* of the other two sides: that is 5, the *Hypotenusæ* multiplyed in 5 makes 25, and 3 multiplyed in 4 makes 16, and 3 multiplied in 3, makes 9: but 9 and 16 is equall to 25: or if these *numbers* 3, 4, 5, bee doubled, *viz.* 6, 8, 10: the square of 10 is equall to the square of 8 and 6, *viz.* 10 times 10 makes 100, and 8 times 8 makes 64, and 6 times 6 is 36; which

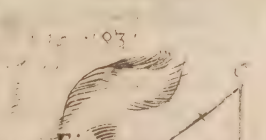
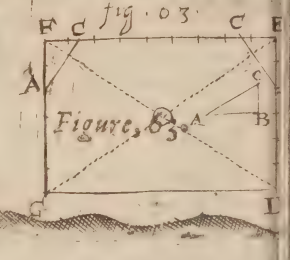


Figure 54.

36 and 64, put together makes 100 as before: and so may they be *Tripled, Quadrupled, &c.*

The use of these *numbers* 3, 4, 5, are manifold, but it may bee applied thus, for the helpe of such which plot out *gardens*, *houses*, encampe *horse* or *foote*, &c. Example, take 3 *cords*: one of 5 *yards*, another of 4 *yards*, and another of 3 *yards*; or the *double*, *triple*, *decuple*, *&c.* or all in one line: and make knots at the tearmes of these measures; so these three parts will make a right angled Triangle, as *A. B. C.* and it is easie with this Triangular cord to plot out a *garden plot*: a square *building plot*, or other long square. As suppose there is a figure *E. D. G. F.* to bee plotted: *E. D.* of 60 *yardes* broad, and *D. G.* 100 *yardes* long. First measure out *E. D.* 60 *yardes*, and at *E.* and *D.* place two *pinnes* or *pegges*; then at *E.* place the *angle* of your *Triangular cord B*, and let the line of the *Triangle A. B.* be in the line *E. D:* which suppose at *A:* make the cord *A. B.* fast in *E.* and *A*, then put the other two *cords* of the *Triangle* untill they meete, which will be in *C*, and place a *pegge* at *C:* take afterwards a long *cord*, and by the points *E.* and *C.* augment it unto *F.* 100 *yards* from *E*, and at *F* place a *pegge*: then at *F*, apply your *Triangular*



cord

ord as you did at *E*, and so may you draw the ine *F. G.* as long as *E. D*, viz. 60 *yards*. Lastly t is easie to draw the line *G. D*, and so the re-tanguled figure or long square shall be plotted, vhose bredth is 60 *yards*, and length 100 *yards* s was required: and to examine this, measure *E. G*, then if *F. D.* be as long, the figure is true: otherwise it is defective and may easily bee a-nended.

If one bee taken from any *square number* which is odde, the *square* of halfe of it being dded to the first *square*, will make a *square umber*. 9

The *square* of halfe any even *number* ✠. 1 eing added to that even *number* makes a *square umber*, and the even *number* taken from it eaves a *square number*. 10

If odde *numbers* bee continually added from ne unitie successively, there will bee made all *quare numbers*, and if *cubicke numbers* bee ad-ed successively from the unitie, there will bee kewise made *square numbers*. 11

PROBLEM. LXV.

Of an excellent lampe which serves or furnisheth it selfe with oyle, and burnes a long time.

Speake not here of a common *lampe* which *Cardanus* writes upon in his book *de subtilitate*, for thats a little vessell in collumne-wise, which

which is full of *oyle*, and becauſe there is but one little hole at the bottome neare the weeke or match; the *oyle* runnes not, for feare that there be emptineſſe above: when the match is kindled it begins to heat the lampe, and rarifying the *oyle* it iſſueth by this occaſion: and ſo ſends his more aire parts above to avoide vacuitie.

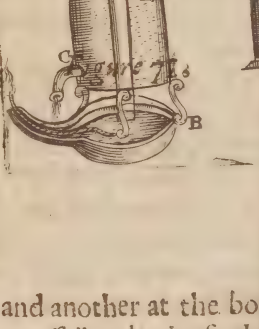


Figure 71.

But that which I here deliver is more ingenious, the principall peece of which is a *veſſell* as *C.D:* which hath neare the bottome a hole, and a funnell or pipe *C:* & then a bigger funnell which paſſeth through the middle of the *veſſell*, having an opening at *D.* neare the *E* top, and another at the bottome as at *E*, neare the *veſſell* under it, ſo that the pipe touch it not: the *veſſell* being thus made, fill it with *oyle*, and opening the hole *C.* the *oyle* running out will ſtop the hole at *E*: or throwing in *oyle* into the *veſſell* underneath, untill *E.* bee ſtopped; then the *oyle* at *C.* will not runne: becauſe no aire can come into the pipe *D. E.* Now as the *oyle* burneth and conſumeth in the veſſell *A. B.* the hole at *E*, will begin to be open, then immediatly will *C.* begin to runne to fill up *A B:* and *E* being ſtopped with the *oyle*, the *oyle* at *C.* ceaſeth to run.

I

It is certaine that such a *lampe* the *Athenians* ..ed, which lasted a whole yeare without being touched: which was placed before the statue of *Minerva*, for they might put a certaine quantitie of oyle in the *lampe C. D*, and a match to burne without being consumed: such as the naturallists write of, by which the *lampe* will furnish it selfe and so continue in burning: and here may be noted that the *oyle* may be powred in at the top of the *vessell* at a little hole, & then made fast againe that the aire get not in.

PROBLEM. LXV.

Of the play at Keyles or nine Pinnes.

YOu will scarce beleeve that with one bowle and at one blow playing freely, one may strike downe all the Keyles at once: yet from *Mathematicall* principles it is easie to bee demonstrated, that if the hand of him that playes was so well assured by experience, as reason inviceth one thereto: one might at one blow strike downe all the Keyles, or at least 7 or 8, or such a number as one pleaseth.

For they are but 9 in all disposed or placed in a perfect *square*, having three every way. Let us suppose then that a good player beginning to play at 1 somewhat low, should so

ſtrike it, that it ſhould ſtrike down the Keyles 2 and 5, and theſe might in their violence ſtrike down the Keyles 3, 6, and 9: and the bowle being in motion may ſtrike downe the Keyle 4, and 7; which 4 Keyle may ſtrike the Keyle 8: and ſo all the 9 Keyles may bee ſtriken downe at once.

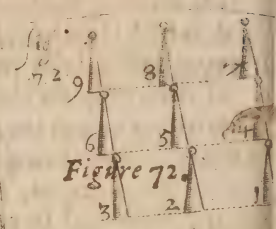


Figure 72.

PROBLEM. LXVI.

Of Spectacles of pleaſure.

SImple *Spectacles* of *blew*, *yeallow*, *red* o *greene* colour, are proper to recreate th ſight, and will preſent the objects died in lik colour that the *Glaſſes* are, onely thoſe of th *greene* doe ſomewhat degenerate; inſtead o ſhewing a lively colour it will repreſent a pal dead colour, and it is becauſe they are not dye greene enough, or receive not light enough fo greene: and colour theſe images that paſ through theſe *Glaſſes* unto the bottome of th eye.

EXAMINA

EXAMINATION.

T is certaine that not onely Glasses *dyed green, but all other* Glasses *coloured, yeeldes the appearances of objects strong or weake in* colour *according to the quantity of the dye, more or lesse, one being very* yellow, *another a* pale yellow; *w all colours are not proper to* Glasses *to give lour, hence the defect is not that they want ocultie to receive light, or resist the penetration the beames, for in the same* Glasses *those which e most dyed, gives alwayes the objects more gh* coloured *and obscure, and those which are sse dyed gives them more pale and cleare: and is is dayly made manifest by the painting of* Glasses, *which hinders more the penetration of the ght than dying doth, where all the matter by re is forced into the* Glasse, *leaving it in all parts ransparant.*

Spectacles *of* Crystall *cut with diverse* Angles *imond-wise doth make a marvelous multiplication of the appearances, for looking towards a ouse it becomes as a* Towne, *a* Towne *becomes ke a* Citie, *an* armed man *seems as a whole* company *caused soly by the diversity of refractions, r as many plaines as there are on the out side of he* Spectacle, *so many times will the object be ultiplyed in the appearance, because of diverse nages cast into the eye.*

These are pleasurable Spectacles *for avaritious persons that love* gold *and* silver, *for one peece will seeme many, or one heape of money will seeme as a treasury: but all the mischiefe is he will not have his end in the injoying of it, for indeavoring to take it, it will appeare but a deceitfull* image, *or delusion of nothing. Here may you note that if the finger be directed by one and the same ray or beam, which pointeth to one & the same object, then at the first you may touch that visible object without being deceived: otherwise you may faile often in touching that which you see.*

Againe there are Spectacles *made which doe diminish the thing seene very much, and and brings them to a faire perspective forme, especially if one looke upon a faire* garden plot, *a greater* walke, *a stately* building, *or great* court, *the industry of an exquisite* Painter *cannot come neare to expresse the lively forme of it as this* Glasse *will represent it; you will have pleasure to see it really experimented, and the cause of this is, that the* glasses *of these* Spectacles *are hollow' & thinner in the middle, than at the edge by which the visuall* Angle *is made lesser: you may observe a further secret in these* Spectacles *for in placing them upon a window one may see those that passe to and fro in the streets, without being seene of any; for their property is to raise up the objects that it lookes upon.*

Now I would not passe this Probleme *without saying something of* Gallileus *admirable* Glasse *for the common simple perspective* Glasses *give to* aged men, *but the eyes or sight of* young men

but

ut this of Gallileus gives a man an Eagles eye,
r an eye that pearceth the heavens: first it disco-
ereth the spottie and shaddowed opacous bodies
hat are found about the Sunne, which darkeneth
id diminisheth the splendor of that beautifull
id shining Luminary: secondly, it shewes the
w planets that accompany Saturne and Iupiter:
irdly, in Venus is seene the new, full, and quar-
ll increase; as in the Moone by her separation
om the Sunne: fourthly, the artificiall structure
this instrument helpeth us to see an innumera-
e number of starres, which otherwise are obscured
reason of the naturall weakenesse of our sight,
a the starres in via lactea are seene most appa-
ntly; where there seemes no starres to be, this
strument makes apparantly to be seene, and
rther delivers them to the eye in their true and
ively colour, as they are in the heavens: in
hich the splendor of some is as the Sunne in his
oft glorious beauty. This Glasse hath also a
oft excellent use in observing the body of the
loone in time of Eclipses, for it augments it
anifold, and most manifestly shewes the true
rme of the cloudy substance in the Sunne; and
it is seene when the shaddow of the earth be-
ns to eclipse the Moone, and when totally shee
overshaddowed: besides the celestiall uses
hich are made of this Glasse, it hath another no-
le property; it farre exceedeth the ordinary per-
pective Glasses, which are used to see things re-
ote upon the earth, for as this Glasse reacheth
to the heavens and excelleth them there in
is performance, so on the earth it claimeth pre-

heminency: for the objects which are farthest remote, and most obscure, are seene plainer than those which are neere at hand, scorning as it were all small and triviall services, as leaving them to an inferiour helpe: great use may be made of this Glasse *in discovering of* Shippes, Armies, &c. *Now the apparell or parts of this* instrument *or* Glasse, *is very meane or simple, which makes it the more admirable (seeing it performes such great service) having but a convex* Glasse *thickest in the middle, to unite and amasse the rayes, and make the object the greater: to augmenting the* visuall Angle, *as also a pipe or truncke to amasse the* Species, *and hinder the greatnes of the light which is about it:* (to see well, the object must be well inlightened, and the eye in obscuritie;) *then there is adjoyned unto it a* Glasse *of a short sight to distinguish the rayes, which the other would make more confused if alone. As for the proportion of those* Glasses *to the* Trunke *though there be certaine rules to make them, yet it is often by hazard that there is made an excellent one, there being so many difficulties in the action, therefore many ought to be tryed, seeing that exact proportion, in* Geometricall calculation *cannot serve for diversity of sights in the* observation.

PROB-

PROBLEME LXVII.

Of the Adamant or Magnes, and the needles touched therewith.

WHo would beleeve if he saw not with his *eyes*, that a *needle* of *steel* being once touched with the *magnes*, turnes not once, not a *yeare*, but as long as the world lasteth; his end towards the *North* and *South*, yea though one remove it, and turne it from his position, it will come againe to his points of *North* and *South*. Who would have ever thought that a brute *stone* blacke and ill formed, touching a ring of *iron*, should hang it in the *aire:* and that ring support a second, that to support a third, and so unto 10, 12, or more, according to the strength of the *magnes*; making as it were a chaine without a line, without souldering together, or without any other thing to support them onely; but a most occult and hidden vertue, yet most evident in this effect: which penitrateth insencibly from the first to the second, from the second to the third, *&c.*

Is it not a wonder to see that a *needle* touched once will draw other *needles*; and so a *nayle*, the point of a *knife*, or other peeces of *iron*. Is it not a pleasure to see how the *magnes* will turne file dust, or move *needles*, or *nayles* being upon a *Table*, or upon a peece of paper; for as soone as the *magnes* turnes, or it moves over, it moues also: who is it that would not bee ra-

vished as it were, to see a hand of *iron*, write upon a *planke*, without seeing the *Magnes* which causeth that motion behinde the *planke*, or to make an *image* of *iron* to runne up and downe a *Turret*: now infinite of such inventions is proper to be extracted from the properties of the *magnes*.

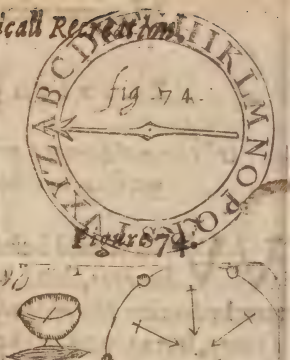


Figure 74.

What is there in the world that is more capable to cast a deeper astonishment in our mindes, than a great massie substance of *iron* to hang in the *aire* in the midest of a building without any thing in the world touching it, only but the *aire*? And histories assure us, that by the aide of a *magnes* or *adamant*, placed at the roofe of one of the *Turkish* Synagogues in *Meca*: the sepulcher of that infamous *Mahomet* rests suspended in the *aire*; and *Plinie* in his *naturall historie* writes that the Architecter *Dinocrates* did begin to vault the Temple of *Arsinoe* in *Alexandria*, with store of *magnes* to produce the like deceit, to hang the sepulcher of that Goddesse likewise in the *aire*.

I should passe the bounds of my counterpoise, if I should divulge all the secrets of this *stone*, and should expose my selfe to the laughter of the world: if I should brag to shew other the cause how this appeareth, than in its owne

naturall

naturall sympathy, for why is it that a *magnes* with one end will cast the *iron* away, and attract it with the other; from whence cometh it that all the *magnes* is not proper to give a true touch to the *needle*, but onely in the two *Poles* of the *stone:* which is known by hanging the stone by a threed in the aire untill it be quiet, or placed upon a peece of *Corke* in a dish of *water*, or upon some thinne board, for the *Pole* of the stone will then turne towards the *Poles* of the world, and point out the *North* and *South*; and so shew by which of these ends the *needle* is to be touched.

From whence comes it that there is a variation in the *needle*, and pointeth not out truly the *North* and *South* of the world, but onely in some place of the earth.

How is it that the *needle* made with pegges and inclosed within two *Glasses*, sheweth the height of the *Pole*, being elevated as many degrees as the *Pole* is above the *Horizon*.

Whats the cause that *fire* and *Garlicke* takes away the propertie of the *magnes*: There are many great hidden misteries in this stone, which have troubled the heads of the most learned in all ages; and to this time the world remaines ignorant of declaring the true cause thereof.

Some sayes that by helpe of the *Magnes* *persons* which are absent may know each others minde, as if one being here at *London*, and another at *Prage* in *Germany:* if each of them had a *needle* touched with one *magnes*, then the vertue is such that in the same time that the

needle

needle which is at *Prage* shall moove, this that is at *London* shall also; provided that the parties have like secret notes or alphabets, and the observation be at a set houre of the day or night; and when the one party will declare unto the other, then let that party move the needle to these letters which will declare the matter to the other, and the mooving of the other parties needle shall open his intention.

The invention is subtile, but I doubt whether in the world there can be found so great a stone, or such a *Magnes* which carries with it such vertue: neither is it expedient, for treasons would be then too frequent and open.

EXAMINATION.

THe experimentall difference of rejection, and attraction proceedes not from the different nature of stones, *but from the quality of the* iron, *and the vertue of the* stone *consisteth onely and especially in his* Poles; *which being hanged in the* aire, *turnes one of his ends alwayes naturally towards the* South, *and the other towards the* North: *but if a rod of* iron *be touched with one of the ends thereof, it hath the like property in turning* North *and* South, *as the* magnes *hath: notwithstanding the end of the* iron rod *touched, hath a contrary position to that end of the stone that touched it; yet the same end will attract it, and the other end reject it: and so contrarily*

ontrarily this may easily be experimented upon two
needles touched with one or different stones, though
they have one and the same position; for as you come
unto thē apply one end of the magnes neare unto thē,
the North of the one will abhorre the North of the
other, but the North of the one will alwayes approach
to the South of the other: and the same affection is
in the stones themselves. For the finding of the
Poles of the magnes, it may be done by holding a
small needle betweene your fingers softly, and so
mooving it from part to part over the stone untill it
be held perpendicular, for that shall be one of the
Poles of the stone which you may marke out; in like
manner finde out the other Pole: Now to finde out
which of those Poles is North or South, place a
needle being touched with one of the Poles upon a
smooth convex body, (as the nayle of ones finger or
such like,) and marke which way the end of the
needle that was touched turneth: if to the South,
then the point that touched it was the South Pole,
&c. and it is most certaine and according to reason
and experience: that if it be suspended in æquilibrio
in the aire, or supported upon the water, it will
turne contrary to the needle that toucheth it; for
then the Pole that was marked for the South shall
turne to the North, &c.

PROB-

PROBLEM. LXVIII.

Of the properties of Æolipiles or bowles to blow the fire.

THese are concave vessels of *brasse* or *copper*, or other materiall which may indure the fire: having a small hole very narrow by which it is filled with *water*, then placing it to the fire, before it bee hot there is no effect seene; but assoone as the heate doth penitrate it, the water begins to rarifie and issueth forth with a hideous and marvellous force; it is pleasure to see how it blowes the fire with great noyse.

Figure 75.

Vitruvious in his first booke of *Architecture*, *Cap.* 8. approves from these *Ingines*, that the winde is no other thing than a quantitie of vapours and exhalations agitated with the aire by *rarifaction* and *condensation*, and wee may draw a consequence from it, to shew that a little *water* may ingender a very great quantitie of vapours and *aire*: for a *Glasse* of *water* throwne into an *Æolipile* will keep blowing neare a hole houre, sending forth his vapoures a thousand times greater than it is extended.

Now

Now touching the forme of these vessels, they are not made of one like fashion: some makes them like a *bowle*, some like a head painted representing the *winde*, some makes them like a *peare*: as though one would put it to rost at the fire, when one would have it to blow, for the tale of it is hollow, in forme of a *funnell*, having at the toppe a very little *hole* no greater than the head of a *pinne*.

Some doe accustome to put within the *Æolipile* a crooked *funnell* of many foldings, to the end that the winde that impetuously rowles to and fro within, may imitate the noyse of thunder.

Others content themselves with a simple *funnell* placed right upward, somewhat wider at the toppe than elsewhere like a *Cone*, whose basis is the mouth of the *funnell*: and there may be placed a bowle of *iron* or *brasse*, which by the vapoures that are cast out will cause it to leape up, and dance over the mouth of the *Æolipile*.

Lastly, some apply neare to hole small *windmills*, or such like, which easily turne by reason of the vapours; or by help of two or more bowed *funnells*, a bowle may be made to turne: these *Æolipililes* are of excellent use for the melting of mettalls and such like.

Now it is cunning and subtiltie to fill one of these *Æolipiles* with water at so little a hole, and therefore requires the knowledge of a *Philosopher* to finde it out: and the way is thus.

Heate the *Æolipiles* being empty, and the aire

aire which is within it will become extreamely rarified; then being thus hot throw it into water, and the aire will begin to bee condenſed: by which meanes it will occupie leſſe roome; therefore the water will immediately enter in at the hole to avoide vacuitie: thus you have ſome practicall ſpeculation upon the *Æolipile*.

PROBLEM. LXIX.

Of the Thermometer: or an inſtrument to meaſure the degrees of heat and cold in the aire.

THis *Inſtrument* is like a *Cylindricall* pipe of *Glaſſe*, which hath a little ball or bowle at the toppe: the ſmall end of which is placed into a veſſell of water below, as by the figure may be ſeene.

Then put ſome coloured liquor into the *Cylindricall glaſſe*, as *blew, red, yealow, greene*, or ſuch like: ſuch as is not thicke. This being done the uſe may he thus.

Firſt, I ſay that as the *aire* inclofed in the *Thermometer* is rarifyed or condenſed, the *water* will evidently aſcend or deſcend in the *Cylinder*: which you may try eaſily by carrying the *Themometer* from a place that is hot unto place that is cold, or without removing of it if you ſoftly apply the palme of the hand upon the balle of the *Thermometer*: the *Glaſſe* being ſo thinne, and the *aire* ſo capable of rarifaction

tha

hat at the very instant you may see the *water* descend: and your hand being taken away, it will softly ascend to his former place againe. This is yet more sencible when one heates the

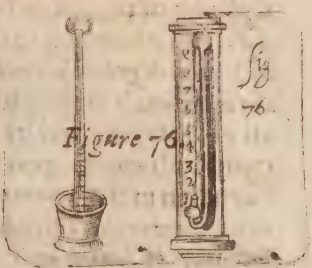


Figure 76.

alist the toppe with his breath, as if one would say a word in his eare to make the vater to descend by ommand: and the eason of this motion s, that the *aire* hea- ed in the *Thermome- er*, doth rarifie and ilate, requiring a reater place; hence resseth the *water* and causeth it to descend: ontrariwise when the aire cooleth and con- enseth, it occupieth lesse roome; now nature horring vacuity, the *water* naturally ascen- eth. In the second place I say, that by this eanes one may know the degrees of heate and old, which are in the *aire* each houre of the ay; for asmuch as the exterior *aire* is either ot or cold, the *aire* which is inclosed in the *hermometer* doth likewise either rarifie or ondense, and therefore the *water* ascends or escends; so you shall see that the *water* in the orning is mounted high, afterward by little ad little it will descend towards noone or mid- ay; and towards evening it will againe ascend: o in *winter* it will mount so high, that all the *ylinder* of the *Thermometer* will bee full, but

in

in *Summer*, it will descend so low that scarce there will be perceaved in it any water at all.

These that will determine this change by *numbers* and degrees, may draw a line upon the *Cylinder* of the *Thermometer*; and divide it into 4 *degrees*, according to the ancient *Philosophers*, or into 4 *degrees* according to the *Physitians*, dividing each of these 8 into 8 others: to have in all 64 *divisions*, and by this way they may not onely distinguish upon what degree the water ascendeth in the *morning*, at *midday*, and at any other *houre:* but also one may know how much one day is *hotter* or *colder* than another: by marking how many degrees the *water* ascendeth or descendeth, one may compare the *hottest* and *coldest* dayes in a whole yeare together with these of another yeare: againe one may know how much *hotter* one roome is than another, by which also one might keepe a *chamber*, a *furnis*, a *stove*, &c. alwayes in an equalitie of heate, by making the *water* of the *Thermometer* rest alwayes upon one and the same degree: in briefe, one may judge in some measure the burning of *fevers*, and neare unto what extension the aire can bee rarified by the greatest heate.

Many make use of these glasses to judge o the weather, for it is observed that if the wate fall in 3 or 4 houres a *degree* or thereabout, tha raine insueth; and the water will stand at tha stay, untill the weather change: marke the wa ter at your going to bed, for if in the morni it hath descended *raine* followeth, but if it be

mounte

nounted higher, it argueth *faire weather*: so n very cold weather, if it fall suddainly, it is *now* or some sleekey weather that will insue.

PROBLEM. LXX.

Of the proportion of humaine bodies of Statues, of Colossus or huge images, and of monstrous Giants.

PYthagoras had reason to say that man is the measure of all things.

First, because he is the most perfect amongst l bodily *creatures*, and according to the *Maxime* of *Philosophers*, *that which is most perfect, nd the first in ranke, measureth all the rest.*

Secondly, because in effect the ordinary measure of a *foote*, the *inch*, the *cubit*, the *pace*, have ken their names and greatnesse from *humaine odies.*

Thirdly, because the *simmetrie* and concordancie of the parts is so admirable, that all orkes which are well proportionable, as amely the building of *Temples*, of *Shippes*, of illars, and such like peeces of *Architecture*, e in some measure fashioned and composed ter his proportion. And we know that the *rke of Noah* built by the commandement of od, was in length 300 *cubits*, in bredth 50 *ubits*, in height or depth 30 *cubits*, so that the ngth containes the bredth 6 times, and 10 mes the depth: now a man being measured

you will finde him to have the same proportion in length, breadth, and depth.

Vilalpandus treating of the *Temple of Salomon*, that chiefetaine of workes was modulated all of good *Architecture*, and curiously to be observed in many peeces to keepe the same proportion as the body to his parts: so that by the greatnesse of the worke and proportionable *symmetrie*, some dare assure themselves that by knowledge of one onely part of that *building*, one might know all the measures of that goodly structure.

Some *Architects* say that the foundation of *houses*, and basis of *columnes*, are as the *foote*; the *top*, and *roofe* as the *head*; the rest as the *body*: those which have beene somewhat more curious, have noted that as in *humaine bodies*, the parts are uniforme as the *nose*, the *mouth*, &c. these which are double are put on one side or other, with a perfect equallitie in the same *Architecture*.

In like manner, some have beene yet more curious than solid; comparing all the ornaments of a *Corinth* to the parts of the *face*, as the *brow*, the *eyes*, the *nose*, the *mouth*; the rounding of *pillars*, to the writhing of haire, the chanells of columnes, to the fouldings of womens *robes*, &c.

Now *building* being a worke of the best *Artist*, there is much reason why man ought to make his imitation from the chiefe worke of nature; which is man.

Hence it is that *Vitruvious* in his third book, and

and all the beſt *Architectures*, treateth of the proportion of man; and amongſt others *Albert Dureus* hath made a whole booke of the meaſures of mans body, from the foot to the head; let them reade it who will, they may have a perfect knowledge therof: but I will content my ſelfe, and it may ſatisfie ſome with that which followeth.

Firſt, the length of a *man* well made, which commonly is called height, is equall to the diſtance from one end of his *finger* to the other: when the *armes* are extended as wide as they may be.

Secondly, if a *man* have his feet and hands extended or ſtretched in forme of S, *Andrewes Croſſe*, placing one foote of a paire of *Compaſſes* upon his *navill*, one may deſcribe a *circle* which will paſſe by the ends of his hands and feet, and drawing lines by the termes of the hands and feet, you have a ſquare within a *circle*.

Thirdly, the breadth of *man*, or the ſpace which is from one ſide to another; the *breaſt*, the *head*, and the *necke*, makes the 6 part of all the *body* taken in length or height.

Fourthly, the length of the *face* is equall to the length of the *hand*, taken from the ſmall of the *arme*, unto the extremity of the longeſt *finger*.

Fiftly, the thickeneſſe of the *body* taken from the *belly* to the *backe*; the one or the other is the tenth part of the whole *body*, or as ſome will have, it the ninth part, little leſſe.

Sixtly, the height of the *brow*, the length of

the *nose*, the space betweene the *nose* and the *chinne*, the length of the *eares*, the greatnesse of the *thumbe*, are perfectly equall one to the other.

What would you say to make an admirable report of the other parts, if I should reckon them in their least; but in that I desire to be excused, and will rather extract some conclusion upon that which is delivered.

In the first place knowing the proportion of a *man*, it is easie to *Painters*, *image*-makers, &c. perfectly to proportionate their worke; and by the same is made most evident, that which is related of the *images* and statues of *Greece*, that upon a day diverse workemen having enterprised to make the face of a *man*, being severed one from another in sundry places, all the parts being made and put together, the face was found in a most lively and true proportion.

Secondly, it is a thing most cleare that by the helpe of proportion, the body of *Hercules* was measured by the knowledge of his *foote* onely; a *Lyon* by his *claw*, the *Gyant* by his *thumbe*, and a *Man* by any parte of his body. For so it was that *Pythagoras* having measured the length of *Hercules* foote, by the steps which was left upon the *ground*, found out all his height: and so it was that *Phydias* having onely the claw of a *Lyon*, did figure and draw out all the beast according to his true type or forme; so the exquisite Painter *Timantus*, having painted a *Pigmey* or Dwarfe, which he measured with a *fadome* made with the inch of a *Gyant*; it was sufficient

ent to know the greatneſſe of that *Gyant.*

To be ſhort, we may by like methode come eaſily to the knowledge of many fine antiquities touching *Statues*, *Coloſſes*, and monſtrous *Gyants*, onely ſuppoſing one had found but one only part of them, as the *head*, the *hand*, the *foote*, or ſome bone mentioned in ancient *Hiſtories.*

Of Statues, of Coloſſus, or hnge images.

Vitruvius relates in his ſecond booke that the *Architect Dinocrates* was deſirous to put out to the world ſome notable thing, went to *Alexander* the great, and propoſed unto him a high and ſpeciall peece of worke which he had projected: as to figure out the mount *Athos* in forme of a great *Statue*, which ſhould hold in his right hand a *Towne* capable to receive *ten thouſand men:* and in his left hand a *veſſell* to receive all the water that floweth from the *mountaine*, which with an ingine ſhould caſt into the *Sea.* This is a pretty project, ſaid *Alexander*, but becauſe there was not field roome thereabout to nouriſh and retaine the *Citizens* of that place, *Alexander* was wiſe not to entertaine the deſigne.

Now let it bee required of what greatneſſe his *Statue* might have beene, the *Towne* in his right hand, and the receiver of water in his left hand if it had beene made.

For the *Statue*, it could not bee higher than the *mountaine* it ſelfe, and the *mountaine* was about a mile in height plume or perpendicular;

therefore the hand of this *Statue* ought to bee the 10th part of his height, which would bee 500 *foote*, and so the bredth of his hand would be 250 *foote*; the length now multiplyed by the bredth, makes *an hundred twenty five thousand square feete*; for the quantitie of his *hand* to make the towne in, to lodge the said 10 *thousand men*, allowing to each man neere about 12 *foote of square ground:* now judge the capacitie of the other parts of this *Colossus* by that which is already delivered.

Secondly, *Plinie* in his 34 booke *of his naturall Historie*, speakes of the famous *Colossus* that was at *Rhodes*, betweene whose legges a *Shippe* might passe with his *sailes* open or displayed, the *Statue* being of 70 *cubits high:* and other Histories reports that the *Sarazins* having broken it, did load 900 *Camells* with the mettle of it, now what might be the greatnes and weight of this *Statue*.

For answere it is usually allowed for a *Cammells* burthen 1200 pound weight, therefore all the *Colossus* did weigh 1080000 pound weight, which is ten hundred and forescore thousand pound weight.

Now according to the former rules, the *head* being the tenth part of the *body*, this *Statues head* should bee of 7 *cubits*, that is to say, 10 *foote* and a halfe; and seeing that the *nose*, the *brow*, and the *thumbe*, are the third part of the *face*; his *nose* was 3 *foote* and a halfe long, and so much also was his *thumbe* in length: now the thicknesse being alwayes the third part of

the

the length, it should seeme that his *thumbe* was a foote thicke at the least.

Thirdly, the said *Plinie* in the same place reports that *Nero* did cause to come out of *France* into *Italy*, a brave and bold *Statue*-maker called *Zenodocus*, to erect him a *Colossus* of *brasse*, which was made of 120 foot in *height*, which *Nero* caused to bee painted in the same height. Now would you know the greatnesse of the members of this *Colossus*, the breadth would be 20 *foote*, his *face* 12 *foote*, his *thumbe* and his *nose* 4 *foote*, according to the proportion before delivered.

Thus I have a faire *field* or subject to extend my selfe upon, but it is upon another occasion that it was undertaken; let us speake therefore a word touching the *Gyants*, and then passe away to the matter.

Of monstrous Gyants.

YOu will hardly beleeve all that which I say touching this, neither will I beleeve all that which *Authors* say upon this subject: notwithstanding you nor I cannot deny but that long agoe there hath beene men of a most prodigious greatnesse; for the *holy writings* witnesse this themselves in *Deut. Chap.* 3. that there was a certaine *Gyant* called *Ogge*, of the Towne of *Rabath*, who had a bed of *iron*, the length thereof was 9 *cubits*, and in bredth 4 *cubits*.

So in the first of *Kings Chap.* 17. there is

mention made of *Goliah*, whose height was 2 palme and 6 *cubits*, that is more then 9 *foote*, he was armed from the *head* to the *foote*, and his *Curiat* onely with the iron of his *lance*, weighed five thousand and sixe hundred sicles, which in our common weight, is more than 233 pound, of 12 ounces to the pound. Now it is certaine that the rest of his *armes* taking his *Target*, *Helmet*, *Braselets*, and other *Armour* together, did weigh at the least 5 hundred pound, a thing prodigious; seeing that the strongest man that now is, can hardly beare 200 pound, yet this *Gyant* carries this as a *vesture* without paine.

Solinus reporteth in his 5 *Chap.* of his *Historie*, that during the *Grecians* warre after a great overflowing of the *rivers*, there was found upon the sands the *carkasse* of a *man*, whose length was 33 *cubits*, (that is 49 *foote* and a halfe) therefore according to the proportion delivered, his *face* should bee 5 *foote* in length, a thing prodigious and monstrous.

Plinie in his 7. booke and 16. *Chap.* saith, that in the Ile of *Crete* or *Candie*, a mountaine being cleaven by an *earthquake*, there was a body standing upright, which had 46 *cubits* of height: some beleeves that it was the body of *Orion* or *Othus*, (but I thinke rather it was some *Ghost* or some delusion,) whose *hand* should have beene 7 foote, and his *nose* two foot and a half long. But that which *Plutarch* in the life of *Sertorius* reports of is more strange, who saith that in *Timgy* a *Morative Towne*;

where

where it is thought that the *Gyant Antheus* was buried, *Sertorius* could not beleeve that which was reported of his prodigious greatneſſe, cauſed his ſepulcher to bee opened, and found that his body did containe 60 *cubits* in length, then by proportion hee ſhould bee 10 *cubits* or 15 foote in bredth; 9 foote for the length of his *face*, 3 foote for *his thumbe*, which is neare the capacitie of the *Coloſſus* at *Rhodes*.

But behold here a fine fable of *Symphoris Campeſius*, in his booke intituled *Hortus Gallicus*, who ſayes that in the *Kingdome* of *Sicile*, at the foote of a mountaine neare *Trepane*, in opening the foundation of a *houſe*, they found a *Cave* in which was laid a *Gyant*, which held in ſtead of a ſtaffe a great poſt like the maſt of a *Shippe*: and going to handle it, it mouldered all into aſhes except the bones which remained of an exceeding great meaſure, that in his head there might be eaſily placed 5 quarters of *corne*, and by proportion it ſhould ſeeme that his length was 200 *cubits*, or 300 *foote*: if he had ſaid that hee had beene 300 *cubits* in length, then he might have made us beleeve that *Noahs Arke* was but great enough for his ſepulcher.

Who can beleeve that any man ever had 20 *cubits*, or 30 foote in length for his *face*, and a *noſe* of 10 foote long? but it is very certaine that there hath been men of very great ſtature, as the holy Scriptures before witneſſeth, and many *Authours* worthy of beliefe relateth: *Ioſephus Acoſta* in his firſt booke of the *Indian Hiſtory*, *Chap.* 19. a late writer, reporteth that at

at *Peru* was found the bones of a *Gyant*, which was 3 times greater then these of ours are, that is, 18 foote: for it is usually attributed to the tallest ordinary man in these our times but 6 foote of length; and *Histories* are full of the description of other *Gyants* of 9, 10, and 12 foote of height, and it hath beene seene in our times some which have had such heights as these.

Problem. LXXI.

Of the game at the Palme, at Trappe, at Bowles, Paile-maile and others.

The *Mathematickes* often findeth place in sundry *Games* to aide and assist the *Gamesters*, though not unknowne unto them: hence by *Mathematicall* principles, the games at *Tennis* may be assisted; for all the moving in it is by right lines and reflections. From whence comes it, that from the appearances of flat or convex *Glasses*, the production and reflection of the species are explained; is it not by right lines? in the same proportion one might sufficiently deliver the motion or a *balle* or *bowle* by *Geometricall lines* and *Angles*.

But the exercise, experience, and dexteritie of the player seemes more in this action than any any other precepts: notwithstanding I will deliver here some *maximes*, which being reduced to practice, and joyned to experience, will give

give a great advantage to thoſe which would make uſe of them in ſuch gamings.

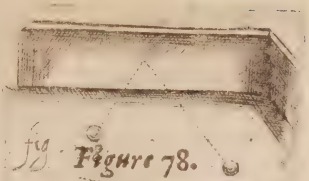


Figure 78.

And the firſt *maxime* is thus: When a *Bowle* toucheth another *Bowle*, or when a trapſticke ſtriketh the *Balle*, the moving of the *Balle* is made in a right line, which is drawne from the Center of the *Bowle* by the point of contingencie.

Secondly, in all kinde of ſuch motion; when a *Balle* or *Bowle* rebounds, be it either againſt *wood*, a *wall*, upon a *Drumme*, a *pavement*, or upon a *Racket*; the incident Angle is alwayes equall to the Angle of reflection.

Now following theſe *maximes* it is eaſie to conclude, firſt in what part of the wood or wall, one may make the *Bowle* or *Balle* goe to reflect or rebound, to ſuch a place as one would: *Secondly*, how one may caſt a *Bowle* upon another, in ſuch ſort that the firſt or the ſecond ſhall goe and meete with the third, keeping the reflection or Angle of incidence equall. *Thirdly*, how one may touch a *Bowle* to ſend it to what part one pleaſeth: ſuch and many other practices may bee done. At the exerciſes at *Keyles* there muſt be taken heed that the motion, ſlacke or diminiſheth by little and little, and may

may bee noted that the *Maximes* of reflections cannot be exactly obſerved by locall motion, as in the beames of light and of other quallities, whereof it is neceſſary to ſupply it by induſtry or by ſtrength, otherwiſe one may be fruſtrated in that reſpect.

PROBLEM. LXXII.

Of the Game of ſquare formes.

NVmbers have an admirable ſecrecie, diverſly applyed, as before in part is ſhewed, and here I will ſay ſome thing by way of tranſmutation of *numbers*.

It is reported that at a certaine paſſage of a ſquare forme, there were 4 gates oppoſite one to another, that is, one in the middle of each ſide, and that there was appointed 9 men to defend each front thereof, ſome at the gates, and the other at each corner or Angle, ſo that each Angle ſerved to aſſiſt two faces of the *ſquare* if neede required: Now this *ſquare paſſage* being thus manned to have each ſide 9, it hapned that 4 *Souldiers* comming by, deſired of the *Governour* of the *paſſage*, that they might bee entertained into ſervice, who told them hee could not admit of more then 9, upon each ſide of the *ſquare*: then one of the *Souldiers* being verſed in the *Art* of *numbers*, ſaid that if he would take them into pay, they would eaſily place themſelves amongſt the reſt, and yet keepe

keepe ſtill the order of 9, for each face of the *ſquare* to defend the *Angles* and *Gates*, to which the *Gouernours* agreed, & theſe *Souldiers* being there ſome few weekes liked not their ſervice, but indeavoured to remove themſelves, and ſo laboured with ſome of the reſt; that each of theſe foure *Souldiers* tooke away his Cumrade with him, and ſo departed: yet left to defend each ſide of the *paſſage*, and how may this be.

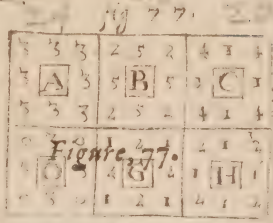


Figure 77.

Its anſwered thus, in the firſt forme the men were as the figure *A*, then each of theſe 4 *Souldiers* placed themſelves at each *Gate*, and removing one man from each *Angle* to each *Gate*, then would they be alſo 9 in each ſide according to the figure *B*. *Laſtly*, theſe 4 *Souldiers* at the *Gates* take away each one his *Cumrade*, and placing two of theſe men which are at each *Gate* to each *Angle*, there will bee ſtill 9 for each ſide of ths *ſquare*, according to the figure *C*. In like manner if there were 12 *men*, how might they be placed about a *ſquare* that the firſt ſide ſhall have 3 every way, then diſordered, ſo that they might be 4 every way; and laſtly being tranſported might make 5 every way, and this is according to the figures, *F*. *G*. *H*.

PRO-

Problem. LXXIII.

How to make the string of a Viole sencibly shake, without any one touching it.

THis is a miracle in *musicke*, yet easie to bee experimented; take a *Viole* or other *Instrument*, and choose two *strings*, so that there bee one betweene them; make these two *strings* agree in one and the same *tune:* then move the *Viole bow* upon the greater *string*, and you shall see a wonder: for in the same time that that shakes which you play upon, the other will likewise sencibly shake without any one touching it;and it is more admirable that the *string* which is betweene them will not shake at all: and if you put the first *string* to another *tune* or note, and loosing the pin of the *string*, or stopping it with your *finger* in any fret, the other *string* will not shake: and the same will happen if you take two *Violes*, and strike upon a *string* of the one, the *string* of the other will sencibly shake.

Now it may bee demanded how comes this shaking, is it in the occult sympathie, or is it in the *strings* being wound up to like notes or tunes, that so easily the other may receive the impression of the *aire*, which is agitated or moved by the shaking or the trembling of the other: and whence is it that the *Viole bow* moved upon the first *string*, doth instantly in the same time move the third *string* and not the second;

if

f the cause be not either in the first or second: leave to others to discant on.

EXAMINATION.

IN this Examination *we have something else to imagine, than the bare sympathie of the* Cords *one to another: for first there ought to be onsidered the different effect that it produceth y extension upon one and the same* Cord *in cacitie: then what might be produced upon diffe-nt* Cords *of length and bigness to make them ccord in a unison or octavo, or some consort inrmediate: this being naturally* examined, *it ill be facill to lay open a way to the knowledge the true and immediate cause of this noble and dmirable* Phenomeny. *Now this will sencibly ppeare when the* Cords *are of equall length and eatness, and set to an unison; but when the* ords *differ from their equalitie, it will be lesse ncible hence in one and the same* Instrument: ords *at a unison shall excite or shake more than at which is at an octavo, and more than those hich are of an intermediate proportionall con-t: as for the other consorts they are not expted, though the effect be not so sencible, yet re in one than in another: and the experiment ll seeme more admirable in taking two* Lutes, oles &c. *and in seting them to one tune: then in touching the* Cord *of the one, it will*

give

give a ſencible motion to the Cord *of the other: and not onely ſo but alſo a harmony.*

PROBLEM. LXXIIII.

Of a veſſell which containes three ſeverall kindes of liquor, all put in at one bung-hole, and drawne out at one tappe ſeverally without mixture.

THe veſſell is thus made, it muſt be divided into three *ſells* for to containe the three *liquors*, which admit to be *Sacke*, *Clarret*, and *Whitewine*: Now in the *bung-hole* there is an *Ingine* with three *pipes*, each extending to his proper *ſell*, into which there is put a *broach* or *funnell* pierſed in three places, in ſuch ſort that placing one of the *holes* right againſt the *pipe* which anſwereth unto him, the other two *pipes* are ſtopped; then when it is full, turne the *funnell*, and then the former hole will be ſtopped and another open, to caſt in other wine without mixing it with the other.

Now to draw out alſo without mixture, at the bottome of the veſſell there muſt be placed a *pipe* or *broach* which may have three *pipes*, and a *cocke* pierſed with three holes ſo artificially done, that turning the *cocke*, the hole which anſwereth to ſuch of the *pipes* that is placed at the bottome, may iſſue forth ſuch *wine* as belongeth to that *pipe*, and turning the Cocke to another *pipe*, the former *hole* will bee ſtopped:

and

nd ſo there will iſſue
orth another kinde
f *wine* without any
ixtures; but the
Cocke may bee ſo or-
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ome out by it two
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hree kindes at once:
ut it ſeemes beſt
vhen that in one *veſ-*
ell and at one *Cocke*,

Figure 81.

man may draw ſeverall kindes of *wine*, and which he pleaſeth to drinke.

PROBLEM. LXXV.

Of Burning-glaſſes.

IN this inſuing diſcourſe I will ſhew the invention of *Prometheus* how to ſteale fire from *Heaven*, and bring it downe to the *Earth*; this is done by a little round *Gleſſe*, or made of *ſteele*, by which one may light a *Candle* and make it flame, kindle *Fire-brans* to make them burne, melt *Lead*, *Tinne*, *Gould*, and *Silver*, in little time: with as great eaſe as though it had beene put into a *Cruzet* over a great fire.

Have you not read of *Archimedes* of *Syracuſes*, who when he could not come to the Ships of *Marcellus*, which aſſeiged that place, to hinder and impeach their approach, ſhee flung huge

ſtones by his *Ingines* to ſinke them into the *Sea*, and transformed himſelfe into *Iupiter*; thundering downe from the higheſt *Towers* of the *Towne*, his thunderbolts of lightning into the *Shippes*, cauſing a terrible *burning*, in deſpite of *Neptune* and his watery region: *Zonaras* witneſſeth that *Proclus* a brave *Mathematician*, burned in the ſame manner the *Shippes* of *Vitalian*, which was come to aſſeige *Conſtantinople*; and dayly experience may let you ſee great effects of *burning*, for a *Bowle* of *Cryſtall* poliſhed, or a *Glaſſe* thicker in the middle than at the edges, will burne exceedingly; nay a bottle full of water expoſed to the Sunne will burne when the Sunne ſhineth hot, and *children* uſe with a *Glaſſe* to burne *Flies* which are againſt the walles, and their fellowes cloathes.

Figure 82.

pag 130.

But this is nothing to the burning of thoſe *Glaſſes* which are hollow, namely theſe which are of *ſteele* well poliſhed, according to a *parabolicall* or *ovall* ſection: A ſphæricall *Glaſſe*, or that which is according to the ſegment of a *Sphære*, burnes very effectually about the fourth part of the *Diamiter*; notwithſtanding the *Parabolie* and *Eclipticke* ſections have a great effect: by which *Glaſſes* there is alſo diverſe

figures

figures represented forth to the eye.

The cause of this burning is the uniting of the beames of the Sunne, which heates mightily in the point of *concourse* or *inflammation*, which is either by transmission or reflection: Now it is pleasant to behold when one breatheth in the point of *concourse*, or throweth small dust there, or sprinkles vapours of hot water in that place; by which the *pyramidall* point, or point of *inflammation* is knowne. Now some *Authors* promiseth to make *Glasses* which shall burne a great distance off, but yet not seene vulgarly produced, of which if they were made, the *Parabolie* makes the greatest effect, and is generally held to bee the invention of *Archimedes* or *Proclus*.

Maginus in the 5. *Chap.* of his Treatise of spherical *Glasses*, shewes how one may serve himselfe with a *concave Glasse*, to light fire in the shaddow, or neare such a place where the Sunne shines not, which is by helpe of a flat *Glasse*, by which may be made a percussion of the beames of the Sunne into the *concave Glasse*, adding unto it that it serves to good use to put fire to a *Mine*, provided that the combustible matter bee well applyed before the *concave Glasse*; in which hee sayes true: but because all the effect of the practice depends upon the placing of the *Glasse* and the *Powder* which he speakes not of: I will deliver here a rule more generall.

How one may place a *Burning-glasse* with his combustible matter in such sort, that at a con-

venient houre of the day, the Sunne shining, it shall take fire and burne: Now it is certaine that the point of *inflammation* or *burning*, is changed as the Sunne changeth place, and no more nor lesse, then the shaddow turnes about the *stile* of a Dyall; therefore have regard to the Suns motion, and his height and place: a *Bowle* of *Crystall* in the same place that the toppe of the *stile* is, and the *Powder* or other combustible matter under the *meridian*, or houre of 12, 1, 2, 3, &c. or any other houre, and under the Sunnes arch for that day: now the Sunne comming to the houre of 12, to 1, 2, 3, &c. the Sunne casting his beames through the *Crystall Bowle*, will fire the materiall or combustible thing, which meets in the point of burning: the like may be observed of other *Burning-glasses*.

EXAMINATION.

IT is certaine in the first part of this Probleme *that* Conicall concave *and* sphericall Glasses, *of what matter soever, being placed to receive the beames of the* Sunne *will excite heate, and that heate is so much the greater, by how much it is neere the point of concurse or inflamation. But that* Archimedes *or* Proclus *did fire or burne Shippes with such* Glasses, *the ancient Histories are silent, yea themselves say nothing; besides the great difficultie that doth oppose it in*

remotenesse, and the matter that the effect is to worke upon: Now by a common Glasse *wee fire things neere at hand, from which it seemes very facill to such which are lesse read, to doe it at a farre greater distances, and so by relation some deliver to the world by supposition that which never was done in action: this we say the rather, not to take away the most excellent and admirable effect whith are in* Burning-glasses, *but to shew the variety of antiquity, and truth of Historie: and as touching to burne at a great distance as is said of some, it is absolutely impossible; and that the* Parabolicall *and* Ovall Glasses *were of* Archimedes *and* Proclus *invention, is much uncertaine: for besides the construction of such* Glasses, *they are more difficult than the obtuse concave ones are, and further, they cast not a great heate but neere at hand; for if it bee cast farre off, the effect is little, and the heate weake: or otherwise such* Glasses *must be greatly extended to contract many beames to amasse a sufficient quantity of beames in* Parabolicall *and* Conicall Glasses, *the point of inflammation ought to concurre in a point, which is very difficult to bee done in a due* proportion: *Moreover if the place be farre remote as is supposed before, such a* Glasse *cannot be used but at a great inclination of the* Sunne, *by which the effect of burning is diminished, by reason of the weakenesse of the* Sunne-*beames.*

And here may be noted in the last part of this Probleme, *that by reason of obstacles if one plain* Glasse *be not sufficient; a second* Glasse *may bee*

applyed to help it: that so if by one simple reflection it cannot be done, yet by a double reflexion the Sun-beames *may be cast into the said* Caverne *or* Mine; *and though the reflected beames in this case be weake, yet upon a fit cumbustible matter it will not faile to doe the effect.*

PROBLEM. LXXVI.

Containing many pleasant Questions by way of Arithmeticke.

I Will not insert in this *Probleme* that which is drawne from the *Greeke Epigrams*, but propoſing the *Question* immediatly will give the answere also, without staying to shew the manner how they are answered; in this I will not be tyed to the *Greeke tearmes*, which I account not proper to this place, neither to my purpose; let these reade that will *Diophanta Scheubelius* upon *Euclide* and others, and they may be satisfied.

Of the Asse and the Mule.

IT happened that the *Mule* and the *Asse* upon a day making a voyage, each of them carryed a *Barrell* full of *wine*: now the lasie *Asse* felt her selfe over loaden, complained and bowed under her burthen; which the *Mule* seeing, said unto her being angry, (for it was in the time when beasts spake) thou great *Asse*, wherefore com-

complaineſt thou? if I had but onely one meaſure of that which thou carrieſt, I ſhould be loaden twice as much as thou art, and if I ſhould give a meaſure of my loading to thee, yet my burthen would be as much as thine.

Now how many *meaſures* did each of them carry? Anſwere, the *Mule* did carry 7 *meaſures*, and the *Aſſe* 5 *meaſures*: for if the *Mule* had one of the *meaſures* of the *Aſſes* loading, then the *Mule* would have 8 *meaſures*, which is double to 4: and giving one to the *Aſſe*, each of them would have equall burthens: to wit, 6 *meaſures* a peece.

Of the number of Souldiers that fought before old Troy.

Homer being asked by *Heſiodus* how many *Grecian* Souldiers came againſt *Troy*, who anſwered him thus; the *Grecians*, ſaid *Homer*, made 7 *fires* or had 7 *Kitchins*, and before every *fire*, or in every *Kitchin* there was 50 *broaches* turning to roſt a great quantitie of *fleſh*, and each *broach* had meate enough to ſatisfie 900 men: now judge how many *men* there might be. Anſwere, 315000. that is, *three hundred and fifteene thouſand men*, which is cleare by multiplying 7 by 50, and the product by 900 makes the ſaid 315000.

Of the number of Crownes that two men had.

John and *Peter* had certain number of *crownes*, *Iohn* said to *Peter*, if you give me 10 of your *crownes*, I shall have three times as much as you have: but *Peter* said to *Iohn* if you give me 10 of your *crownes* I shall have 5 times as much as you have: how much had each of them? Answere, *Iohn* had 15 *crownes* and 5 sevenths of a *crowne*, and *Peter* had 18 *crownes*, and 4 sevenths of a *crowne*. For if you adde 10 of *Peters crownes* to those of *Iohns*, then should *Iohn* have 25 *crownes* and 5 sevenths of a *crowne*, which is *triple* to that of *Peters*, viz. 8, and 4 seventhes: and *Iohn* giving 10 to *Peter*, *Peter* should have then 28 *crownes*, and 4 seventhes of a *crowne*, which is *Quintupla*, or 5 times as much as *Iohn* had left, *viz.* 5 *crownes* and 5 seventhes.

In like manner two *Gamesters* playing together, *A.* and *B:* after play *A.* said to *B*, give me 2 *crownes* of thy money, and I shall have twice as much as thou hast: and *B.* said to *A.* give me 2 *crownes* of thy money, and I shall have 4 times as much as thou hast: now how much had each? Answere, *A.* had 3 and 5 seventhes, and *B.* had 4 and 6 seventhes.

About the houre of the day.

SOme one asked a *Mathematician* what a clocke it was, who answered that the rest of the day is foure thirds of that which is past: now judge what a clocke it is. Answere, if the day were according to the *Iewes* and ancient *Romans*, which made it alwayes to bee 12. houres, it was then the 5. houre, and one seventh of an houre, so there remained of the whole day $6\frac{6}{7}$ that is, 6 houres, and 6 seventhes of an houre. Now if you take the $\frac{1}{3}$ of $5\frac{1}{7}$ it is $\frac{12}{7}$ or 1 and $\frac{5}{7}$ which multiplyed by 4 makes 6 and $\frac{6}{7}$ which is the remainder of the day as before: but if the day had beene 24 houres, then the houre had beene 10 of the clocke, and two seventhes of an houre, which is found out by dividing 12, or 24 by $\frac{7}{3}$.

There might have beene added many curious propositions in this kinde, but they would bee too difficult for the most part of people: therefore I have omitted them.

Of Pythagoras Schollers.

Pythagoras being asked what number of *Schollers* hee had, answered, that halfe of them studied *Mathematickes*, the fourth part *Physicke*, the seventh part *Rethoricke*, and besides he had 3 *women*: now judge you saith he, how many *Schollers* I have. Answere, he had in all 28; the halfe of which is 14, the quarter

of

of which is 7, and the seventh part of which is 4: which 14, 7, and 4, makes 25, and the other 3 to make up the 28, were the 3 *women.*

Of the number of Apples given amongst the Graces and the Muses.

THe three *Graces* carrying *Apples* upon a day, the one as many as the other, meet with the 9 *Muses*, who asked of them some of their *apples*; so each of the *Graces* gave to each of the *Muses* alike, and the distribution being made, they found that the *Graces* and the *Muses* had one as many as the other: The question is how many *apples* each *Grace* had, and how many they gave to each *Muse*. To answere the *question*, joyne the number of *Graces* and *Muses* together which makes 12, and so many *apples* had each *Grace*: Now may you take the double, triple, &c. of 12. that is 24, 36, &c. conditionally, that if each *Grace* had but 12, then may there be allotted to each *Muse* but one onely; if 24, then to each 2 *apples*; if 36, then to each *Muse* 3 *apples*; and so the distribution being made, they have a like number, that is, one as many as the other.

Of the Testament or last Will of a dying Father.

A Dying Father left a thousand *crownes* amongst his two *children*; the one being legittimate, and the other a *Bastard*, conditionally

nally that the fifth part which his legittimate *Sonne* should have, should exceed by 10, the fourth part of that which the *Bastard* should have: what was each ones part? Answere, the legittimate *Sonne* had 577 *crownes*, and $\frac{2}{9}$ and the *Bastard* 422 *crownes* and $\frac{2}{9}$: now the fift part of 577 and 7 ninthes is 115, and $\frac{5}{9}$ and the fourth part of 422 and $\frac{2}{9}$ is 105 and $\frac{5}{9}$ which is lesse then $115\frac{5}{9}$ by 10, according to the Will of the *Testator*.

Of the Cuppes of Crasus.

Crasus gave to the *Temple* of the *Gods* sixe *Cups* of *Gould*, which weighed together 600 *Drammes*, but each *Cup* was heavier one than another by one *Dramme*: how much did each of them therefore weigh? Answere, the first weighed 102 *Drammes* and a halfe; the second 101 *Drammes* and a halfe; the third 100 *Drammes* and $\frac{1}{2}$; the fourth 99 and a halfe; the fift 98 and a halfe; and the sixt *Cup* weighed 79 *Drammes* and a halfe: which together makes 600 *Drammes* as before.

Of Cupids Apples.

Cupid complained to his mother that the *Muses* had taken away his *apples*, *Clio*, said he, tooke from me the fift part, *Euterpe* the twelfth part, *Thalia* the eight part, *Melpomene* the twentieth part, *Erates* the seventh part, *Terpomene* the fourth part: *Polyhymnia* tooke away 30, *Vrania* 120, and *Calliope* 300: so

there

there were left me but 5. *Apples*; how many had he in all at the first, I answer 3360.

There are an infinite of such like questions amongst the Greeke Epigrammes: but it would be unpleasant to expresse them all: I will onely adde one more, and shew a generall rule for all the rest.

Of a Mans Age.

A *Man* was said to passe the halfe part of his life in *childhood*, the fourth part in his *youth*, the third part in *Manhood*, and 18. yeares besides in olde age: what might his *Age* be? the answer is, 72. *yeares*: which and all others is thus resolved: multiplie $\frac{1}{2}$. $\frac{1}{4}$. and $\frac{1}{3}$. together, that is, 6. by 4. makes 24. and that againe by 3. makes 72. then take the third part of 72. which is 24. the fourth part of it, which is 18, and the sixth part of it which is 12. these added together make 54. which taken from 72. rests 18. this divided by 18. (spoken in the *Question*) gives 1, which multiplyed by the summe of the parts, viz. 72. makes 72. the *Answer* as before.

Of the Lion of Bronze placed upon a Fountaine with his Epigramme.

OVt of my right *eye* if I let *water* passe, I can fill the *Cisterne* in 2. *dayes*: if I let it passe out of the left *eye*, it wil be filled in 3. *dayes*, if it passe out of my feete the *Cisterne* will bee 4. *dayes* a filling; but if I let the water passe out of my *mouth*, I can fill the *Cisterne* then in 6. *houres*:

houres: in what time ſhould I fill it, if I powre forth the water at all the paſſages at once.

The *Greekes* (the greateſt talkers in the world) variouſly applie this *queſtion* to divers *ſtatues*, and pipes of *Fountaines*: and the ſolution is by the Rule of 3. by a generall Rule, or by *Algeber*.

They have alſo in their *Anthologie* many other *queſtions*, but becauſe they are more proper to exerciſe, than to recreate the *ſpirit*, I paſſe them over as before with ſilence.

PROBLEM. LXXVII.

Divers excellent and admirable experiments upon Glaſſes.

THere is nothing in the world ſo beautifull as *light*: and nothing more recreative to the *ſight*, than *Glaſſes* which reflect: therefore I will now produce ſome experiments upon them, not that I will dive into their depth (that were to lay open a miſterious thing) but that which may delight and recreate the ſpirits: Let us ſuppoſe therefore theſe principles, upon which is built the demonſtration of the apparances which is made in all ſort of *Glaſſes*.

Firſt, that the rayes or beames, which reflecteth upon a *Glaſſe*, maketh the Angle of *Incident* equall to the Angle of *Reflection*, by the firſt Theo. of the *Catoptick* of *Euc.*

Secondly, that in all plaine *Glaſſes*, the *Images* are ſeene in the perpendicular line to the *Glaſſe*

as

as farre within the *Glasse* as it is without it.

Thirdly, in Concave, or Convex *Glasses*, the *Images* are seene in the right line which passeth from the object and through the Center in the *Glasse*. Theo. 17. and 18.

And here you are to understand that there is not meant onely these which are simple *Glasses* or *Glasses* of steele, but all other bodies, which may represent the visible *Image* of things by reason of their reflection, as *water*, *marble*, *mettle*, or such like. Now take a *Glasse* in your hand and make experiment upon that which followeth.

Experiment upon flat and plaine Glasses.

FIrst, a man cannot see any thing in these *Glasses*, if he be not directly and in a perpendicular line before it, neither can hee see an object in these *Glasses*, if it be not in such a place, that makes the Angle of *incidence* equall to the Angle of *reflexion*: therefore when a *Glasse* stands upright, that is, perpendicular to the *Horizon*, you cannot see that which is above, ex the *Glasse* be placed downe flat: and to see that on the right hand, you must bee on the left hand, &c.

Secondly, an *Image* cannot bee seene in a *Glasse*, if it be not raised above the surface of it; or place a *Glasse* upon a wall, you shall see nothing which is upon the plaine of the wall; and place it upon a *Table* or *Horizontall Plaine*, you shall see nothing of that which is upon the *Table*.

Thirdly,

Thirdly, in a plaine *Glasse* all that is seene appeares or seemes to sinke behinde the *Glasse*, as much as the *Image* is before the *Glasse*: as before is said.

Fourthly, as in *water* a *Glasse* lying downe flat, or *Horizontall*, *Towers*, *Trees*, *Men*, or any height doth appeare, inversed or upside downe; and a *Glasse* placed upright, the right hand of the *Image* seemes to bee the left, and the left seemes to be the right.

Fiftly, will you see in a *Chamber* that which is done in the street, without being seene: then a *Glasse* must bee disposed, that the line upon which the *Images* come on the *Glasse*, make the Angle of *incidence* equall to that Angle of *reflexion*.

Sixtly, an height (as suppose *D E.*) may be measured by a plaine *Glasse*; as let the *Glasse* be *G.* placed downe upon the ground, and let the eye bee at *C.* so farre removed from the *Glasse*, that the eye at *C.* may see the toppe of the *Tree E*: in the Angle or edge of the *Glasse* at *A*, but in the line of *reflexion C A*; then measure the distance betweene your foote *B*, and the point *A*: and also the distance betweene the *Glasse A*, and the foote of the *Tree D*, viz. *A D*. Now as often as *A B.* is found

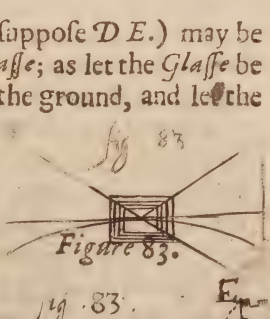


Figure 83.

found in *A D*, so often doth the height of the *Tree E D*. containe the distance from your eye to the foote, *viz. C B*: for the *Triangles A, B, C*, and *A, D, E*, are like *Triangles*: therefore as *B A.* to *A D*, so *C B*, to *E D*, or alternately as *B A.* to *B C*, so *A D.* to *D E.*

Seventhly, present a *Candle* upon a plaine *Glasse*, and looke flauntingly upon it, so that the *Candle* and the *Glasse* bee neere in a right line, you shall see 3. 4 5. &c *Images*, from one and the same *Candle*.

Eightly, take two plaine *Glasses*, and hold them one against the other, you shall alternately see them often times one within the other, yea within themselves, againe and againe.

Ninthly, if you hold a plaine *Glasse* behind your *head*, & another before your *face*, you may see the hinder part of your *head*, in that *Glasse* which you hould before your *face*.

Tenthly, you may have a fine experiment if you place two *Glasses* togeather, that they make an acute angle, and so the lesser the angle is, the more apparances you shall see, the one direct, the other inversed, the one approaching and the other retyring.

Eleventhly, it is wonder and astonishment to some, to see within a *Glasse* an *Image* without knowing from whence it came, and it may be done many wayes: as place a *Glasse* higher than the *eye* of the behoulder, and right against it some *Image*; so it resteth not upon the behoulder, but doth cast the *Image* upwards. Then place another object, so that it reflect, or cast

the *Image* downeward to the *eye* of the ſpectator, without perceiving it being hid behind ſomething, for then the *Glaſſe* will repreſent a quite contrary thing, either than that which is before the *Glaſſe*, or that which is about it.

Twelthly, if there bee ingraved behind the backſide of a *Glaſſe*, or drawne any *Image* upon it, it will appeare before as an *Image*, without any appearance : or portraiture to be perceived.

EXAMINATION.

THis 12. Article *of ingraving an* Image *behind the Glaſſe, will be of no great conſequence, becauſe the linaments will ſeeme ſo obſcure, but if there were painted ſome* Image, *and then that covered according to the uſuall covering of* Glaſſes *behind, and ſo made up like an ordinary looking* Glaſſe *having an* Image *in the middle, in this reſpect it would be ſufficient pleaſant : and that which would admire the Ignorant, and able to exerciſe the moſt ſubtilleſt, and that principally if the* Glaſſe *bee in an obſcure place, and the light which is given to it be ſomewhat farre off.*

PLace a *Glaſſe* neare the floare of a *Chamber*, and make a hole through the place under the *Glaſſe*, ſo that theſe which are below may not perceive it, and diſpoſe a bright *Image* under 13

the hole so that it may cast his species upon the *Glasse*, and it will cause admiration to those which are below that know not the cause; The same may be done by placing the *Image* in a *Chamber* adjoyning, and so make it to be seene upon the side of the *wall*.

In these *Chanell Images* which shew one side *a deaths head*, and another side *a faire face*: and right before some other thing: it is a thing evident, that setting a plaine *Glasse* sidewise to this *Image* you shall see in it a contrary thing, then that which was presented before sidewise.

Lastly, it is a fine secret to present unto a plaine *Glasse* writing with such industrey, that one may reade it in the *Glasse*, & yet out of the *Glasse* there is nothing to be knowne, which will thus happen, if the writing be writ backward: But that which is more strange, to shew a kind of *writing* to a plaine *Glasse*, it shall appeare another kind of writing both against sence and forme, as if there were presented to the *Glasse* WEL. it would shew it MEL if it were written thus MIV, and presented to the *Glasse*, it would appeare thus VIM; for in the first, if the *Glasse* ly flat then the things are inversed that are perpendicular to the *Glasse*, if the *Glasse* and the object be upright, then that on the right hand, is turned to the left, at in the latter.

And here I cease to speake further of these plaine *Glasses*, eyther of the Admirable *multiplications*, or appearances, which is made in a great number of them; for to content the sight

in

in this particular, one must have recourse to the *Cabinets* of great *Personages* who inrich themselves with most beautifull ones.

Experiments upon Gibbous, or convex Spherical Glasses.

IF they be in the forme of a *Bowle*, or part of a great *Globe* of *Glasse*, there is singular contentment to contemplate on them.

First, because they present the objects lesse and more gracious, and by how more the *Images* are separated from the *Glasse*, by so much the more they deminish in *Magnitude*.

Secondly, they that shew the *Images* playting, or moulding, which is very pleasant, especially when the *Glasse* is placed downe, and behold in it some *Blanching, seeling, &c.* The upper part of a *Gallerie*, the porch of a *Hall, &c.* for they will be represented as a great *vessell* having more belly in the middle then at the two ends, and *Posts*, and *Ioists* of *Timber* will seeme as *Circles*.

Thirdly, that which ravisheth the spirits, by the *eye*, and which shames the best perspective *Painting* that a *Painter* can make, is the beautifull contraction of the *Images*, that appeare within the sphericitie of these small *Glasses*, for present the *Glasse* to the lower end of a *Gallarie*, or at the Corner of a great *Court* full of *People*; or towards a great *street*, *Church*, *fortification*, an *Army of men*, to a whole *Cittie*; all the faire *Architecture*, and apparances will

be ſeene contracted within the circuit of the *Glaſſe* with ſuch varietie of *Colours*, and diſtinctions in the leſſer parts, that I know not in the world what is more agreeable to the *ſight* and pleaſant to behold, in which you will not have an exact proportion but it will be variable, according to the diſtance of the Object from the *Glaſſe*.

Experimenss upon hollow, or Concave Spharicall Glaſſes.

I Have heretofore ſpoken how they may burne, being made of *Glaſſe, or Mettle*, it remaines now that I deliver ſome pleaſant uſes of them, which they repreſent unto our *ſight*, and ſo much the more notable it will be, by how much the greater the *Glaſſe* is, and the *Globe* from whence it is extracted.

EXAMINATION.

IN this we may obſerve that a ſection of 2. 3. or 4. Inches *in diamiter, may be ſegments of ſpheares of 2. 3. or 4. foote, nay of ſo many* fadome, *for it is certaine that amongſt theſe which comprehend a great portion of a leſſer* ſpheare, *and theſe which comprehend a little ſegment of a great* ſpheare *whether they be equall or not in ſection, there will happen an evident difference*

in

in one and the same experiment, in the *number*, *situation*, *quantitie*, and *figure* of the *Images* of one or *many different objects*.

Maginus, in a little Tractat that he had upon these *Glasses*, witnesseth of himselfe that he hath caused many to bee polished for sundry great *Lords of Italy*, and *Germanie*, which were segments of *Globes* of 2. 3. and 4. foot diamiter; and I wish you had some such like to see the experiments of that which followeth; it is not difficult to have such made, or bought here in *Towne*, the contentment herein, would beare with the cost.

EXAMINATION.

TOuching Maginus *hee hath nothing ayded us to the knowledge of the truth by his extractout of* Vitelius, *but left it: expecting it from others, rather than to be plunged in the search of it himselfe, affecting rather the forging of the matter, and composition of the* Glasses, *than* Geometrically *to establish their effects.*

FIrst therefore in Concave *Glasses*, the *Images* are seene sometimes upon the surface of the *Glasses*, sometimes as though they were within it and behind it, deepely sunke into it, sometimes they are seene before, and without the *Glasse*, sometimes betweene the object and the

Glasse; sometimes in the place of the *eye*, sometimes farther from the *Glasse* then the object is: which comes to passe by reason of the divers concourse of the beames, and change of the place of the *Images* in the line of flection.

EXAMINATION.

THe relation of these apparances passe currant amongst most men, but because the curious may not receive prejudice in their experiments, some thing ought to bee said thereof to give it a more lively touch, in the true causes of these apparances; in the first place it is impossible that the Image *can be upon the surface of the* Glasse, *and it is a principall point to declare truly in which place the* Image *is seene in the* Glasse: *these that are more learned in* Opticall *knowledge affirme the contrary, and nature it selfe gives it a certaine place according to its position; being alwayes seene in the line of reflection, which* Alhazen, Vitellious, *and others full of great knowledge, have confirmed by their writings: but in their particular they were two much occupied by the authority of the* Ancients, *who were not sufficiently circumspect in experience, upon which the principles of this subject ought to be built, and searched not fully, into the true cause of these apparances, seeing they leave unto posterities many falcities in their writings, and these that follow*

lowe

lowed them for the moſt part fell into the like errors.

As for the Images *to bide in the eye, it cannot be but is impertinent and abſurd; but it followeth that, by how much neerer the object approacheth to the* Glaſſe, *by ſo much the more the appearances ſeemes to come to the eye: and if the eye be without the point of concourſe, and the object alſo; as long as the object approacheth thereto, the repreſentation of the* Image *cometh neere the eye, but paſſing the point of concourſe it goes backe againe: theſe appearances thus approaching doth not a little aſtoniſh theſe which are ignorant of the cauſe: they are inverſed, if the eye be without the point of concourſe untill the object bee within, but contrarily if the eye be betweene the point of concourſe and the* Glaſſe, *then the* Images *are direct: and if the eye or the object be in the point of concourſe, the* Glaſſe *will be enlightened, and the* Images *confuſed; and if there were but a ſparke of fire in the ſaid point of concourſe, all the* Glaſſe *would ſeeme a burning* firebrand, *and we dare ſay it would occurre without chance, and in the night be the moſt certaine and ſubtileſt light that can be, if a* Candle *were placed there. And whoſoever ſhall enter into the ſerch of the truth of new experiments in this ſubject, without doubt hee will confirme what wee here ſpeake of: and will finde new lights with a conveniable poſition to the* Glaſſe, *he will have reflexion of quantities, of truth, and fine ſecrets in nature, yet not knowne, which he may eaſily comprehend if he have but an indifferent ſight, and may aſſure*

himselfe that the Images *cannot exceed the sight, nor trouble it; a thing too much absurd to* nature.

And it is an absolute verity in this science, that the eye being once placed in the line of reflexion of any object, and moved in the same line: the object is seene in one and the same place immutable; or if the Image *and the eye move in their owne lines, the representation in the* Glasse *seemes to invest it selfe continually with a different* figure.

NOw the *Image* comming thus to the eye, these which know not the secret drawes their *sword* when he sees an *Image* thus to issue out of the *Glasse*, or a *Pistoll* which some one holds behinde: and some *Glasses* will shew a *sword* wholly drawne out, separated from the *Glasse*, as though it were in the *aire*: and it is dayly exercised, that a man may touch the *Image* of his hand or his face out of the *Glasse*, which comes out the farther, by how much the *Glasse* is great and the *Center* remote.

EXAMINATION.

NOw *that a* Pistolle *being presented to a* Glasse *behinde a man, and should come out of the* Glasse *and make him afraid, that stands before seeming to shoote at him: this cannot bee,*

for

for no object whatsoever presented to a concave Glasse, *if it be not neerer to the* Glasse *then the eye is, it comes not out to the sight of the party; therefore he needes not feare that which is said to be behinde his backe, and comes out of the* Glasse, *for if it doth come out, it must then necessarily be before his face: so in a concave* Glasse, *whose Center is farre remote; if a sword, sticke, or such like be presented to the* Glasse, *it shall totally be seene to come forth of the* Glasse, *and all the hand that holds it. And here generally note, that if an* Image *bee seene to issue out of the* Glasse *to come towards the face of any one that stands by, the object shall be likewise seene to thrust towards that face in the* Glasse, *and may easily be knowne to all the standers by: so many persons standing before a* Glasse, *if one of the company take a sword and would make it issue forth towards any other that stands there: let him chuse his* image *in the* glasse, *and carry the sword right towards it, and the effect will follow. In like manner ones hand being presented to the* Glasse, *as it is thrust towards the* Center, *so the representation of it comes towards it: and so the hands will seeme to be united, or to touch one another.*

FRom which may bee concluded, if such a *Glasse* be placed at the seeling or planching of a *Hall*, so that the face bee *Horizontall* and looke downeward; one may see under it as it were a *man* hanging by the feete; and if there were many placed so, one could not enter into that place without great feare or scareing: for

one

one should see many *men* in the *aire* as if they were hanging by the feete.

EXAMINATION.

TOuching a Glasse *tyed at a seeling or planching, that one may see a man hang by the feete in the* aire, *and so many* Glasses, *many men may be seene: without caution this is very absurd, for if the* Glasse *or* Glasses *bee not so great that the* Center *of the sphеare upon which it was made, extend not neere to the head of him that is under it, it will not pleasantly appeare; and though the* Glasse *should be of that capacitie that the* Center *did extend so farre, yet will not the* Images *bee seene to them which are from the* Glasse, *but onely to these which are under it, or neere unto it: and to them it will notably appeare, and it would be most admirable to have a* Gallerie *vated over with such* Glasses, *which would wonderfully astonish any one that enters into it: for all the things in the* Gallery *would be seene to hang in the* aire, *and you could not walke without incountering ayrie apparitions.*

SEcondly, in flat or plaine *Glasses* the *Image* is seene equall to his object; and to represent a whole *man,* there ought to be a *Glasse* as great as the *Image* is: In convex *Glasses* the *Images* are seene alwaies lesse, in concave *Glasses* they

they may be seene greater or lesser, but not truly proportionable, by reason the diverse *reflexions* which contracts or inlargeth the Species: when the eye is betweene the Center and the surface of the *Glasse*, the *Image* appeares sometimes very great and deformed, and those which have but the appearance of the beginning of a *beard* on their *chinne*, may cheare up themselves to see they have a great *beard*; these that seeme to be faire will thrust away the *Glasse* with despight, because it will transforme their beauties: these that put their hand to the *Glasse* will seeme to have the hand of a *Gyant*, and if one puts his finger to the *Glasse* it will be seene as a great *Pymamide* of flesh, inversed against his finger.

Thirdly, it is a thing admirable that the eye being approached to the point of concourse of the *Glasse*, there will bee seene nothing but an intermixture or confusion: but retyring backe a little from that point, (because the rayes doth there meete,) he shall see his *Image* inversed, having his head below and his feet above.

Fourthly, the diverse appearances caused by the motion of objects, either retiring or approaching: whether they turne to the *right hand* or to the *left hand*, whether the *Glasse* be hung against a *wall*, or whether it bee placed upon a *Pavement*, as also what may be represented by the mutuall aspect of concave *Glasses*, with plaine and convex *Glasses*: but I will with silence passe them over, onely say some thing of two rare experiments more as followeth.

The

The first is to represent by helpe of the *Sun*, such letters as one would upon the front of a *house:* so that one may reade them; *Maginus* doth deliver the way thus. Write the *letters* saith he sufficiently bigge, but inversed upon the surface of the *Glasse* with some kinde of *colour*, or these letters may bee written with *wax;* (the easier to bee taken out againe:) for then placing the *Glasse* to the *Sunne*, the letters which are written there will bee reverberated, or reflected upon the *wall*: hence it was perhaps that *Pythagoras* did promise with this invention to write upon the *Moone*.

In the second place, how a man may sundry wayes helpe himselfe with such a *Glasse*, with a lighted *Torch* or *Candle*, placed in the point of *concourse* or *inflammation*, which is neare the fourth part of the *Diamiter*: for by this meanes the light of the *Candle* will be reverberated into the *Glasse*, and will be cast backe againe very farre by parrallell lines, making so great a light that one may cleerely see that which is done farre off, yea in the campe of an *Enimie*: and those which shall see the *Glasse* a farre off, will thinke they see a *Silver Basin* inlightened, or a fire more resplendant then the *Torch*. It is this way that there are made certaine *Lanthornes* which dazell the eyes of those which comes against them; yet it serves singular well to enlighten those which carry them, accommodating a *Candle* with a little hollow *Glasse*, so that it may successively bee applyed to the point of *inflammation*.

In

In like manner by this reflected light, one may reade farre off, provided that the letters be indifferent great, as an *Epitaph* placed high, or in a place obscure; or the letter of a friend which dares not approach without perill or suspition.

EXAMINATION.

THis will not bee scarce sencible upon a wall remote from the Glasse, *and but indifferently seene upon a wall which is neare the* Glasse, *and withall it must be in obscuritie or shadowed: or else it will not be seen. To cast light in the night to a place remote, with a* Candle *placed in the point of* concourse *or* inflammation, *is one of the most notablest properties which can be shewne in a concave* Glasse: *for if in the point of* inflammation *of a parabolicall section, a* Candle *bee placed, the light will bee reflected by parallell lines, as a* columne *or* Cylinder; *but in the* sphericall *section it is defective in part, the beames being not united in one point, but somewhat scattering: notwithstanding it casteth a very great beautifull light.*

Lastly, these which feare to hurt their sight by the approach of *Lampes* or *Candles*, may by this artifice place at some corner of a *Chamber*, a *Lampe* with a hollow *Glasse* behinde it,

it, which will commodiously reflect the light upon a *Table*, or to a place assigned: so that the *Glasse* bee somewhat raised to make the light to streeke upon the *Table* with sharpe Angles, as the *Sunne* doth when it is but a little elevated above the *Horizon*: for this light shall exceed the light of many *Candles* placed in the *Roome*, and bee more pleasant to the sight of him that useth it.

Of other Glasses of pleasure.

First, the *Columnary* and *Pyramidall Glasses* that are contained under right lines, doth represent the *Images* as plaine *Glasses* doe; and if they bee bowing, then they represent the *Image*, as the concave and convex *Glasses* doe.

Secondly, those *Glasses* which are plaine, but have ascents of Angles in the middle, will shew one to have foure *eyes*, two *mouthes*, two *noses*, *&c.*

EXAMINATION.

THese experiments will be found different according to the diverse meeting of the Glasses, *which commonly are made scuing wise at the end, by which there will be two diverse superficies in the* Glasse, *making the exteriour Angle somewhat raised, at the interiour onely one superficies, which*

hich may bee covered according to ordinary
ilasses to cause a reflexion, and so it will be but
se Glasse, which by refraction according to the
ifferent thickenesse of the Glasse, and different
Angles of the sceing forme, doe differently pre-
nt the Images to the eye, as foure eyes, two
iouthes, two noses; sometimes three eyes, one
iouth, and one nose, the one large and the other
ng, sometimes two eyes onely: with the mouth
nd the nose deformed, which the Glasse (impe-
itrable) will not shew. And if there be an interi-
ur solid Angle, according to the difference of it,
s if it be more sharpe) there will be represented
vo distinct double Images, that is, two entire vi-
iges, and as the Angle is open, by so much the
iore the double Images will reunite and enter
ne within another, which will present sometimes
whole visage extended at large, to have foure
yes, two noses, and two mouthes; and by mo-
ing the Glasse the Angle will vanish, and so the
wo superficies will be turned into one, and the
uplicitie of Images will also vanish and appeare
ut one onely: and this is easily experimented
ith two little Glasse of steell, or such like so uni-
ed, that they make diverse Angles and inclina-
ions.

THirdly, there are *Glasses* which make men seeme *pale, red*, and coloured in diverse man-
iers, which is caused by the dye of the *Glasse*,
or the diverse refraction of the *Species*: and
hese which are made of *Silver, Latine, Steele,*
&c. doth give the *Images* a diverse colour also.

In

In which one may see that the appearances by some are made *faire, younger* or *older* than they are; and contrarily others will make them foule and deformed: and give them a contrary *visage* for if a *Glasse* bee cut as it may be, or if many peeces of *Glasse* bee placed together to make a conveniable reflexion: there might be made of a *Mole* (as it were) a mountaine, of one *Haire* a *Tree*, a *Fly* to be as an *Elephant*: but I should be too long if I should say all that which might be said upon the property of *Glasses*. I will therefore conclude this discourse of the properties of these *Glasses* with these foure recreative *Problemes* following.

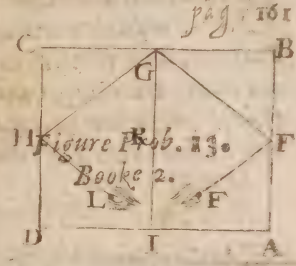
PROBLEM: LXXVIII.

1. *How to shew to one that is suspitious, what is done in another Chamber or Roome: notwithstanding the interposition of the wall.*

FOr the performance of this, there must bee placed three *Glasses* in the two *Chambers*, of which one of them shall bee tyed to the planching or seeling, that it may be common to communicate the *Species* to each *Glasse* by reflexion, there being left some hole at the top of the *wall* against the *Glasse* to this end: the two other *Glasses* must be placed against the two *walls* at right *Angles*, as the figure here sheweth at *B.* and *C.*

Then

Then the sight at *E*. by the line of *incidence* *F E*, shall fall upon the *Glasse B A*, and reflect upon the superficies of the *Glasse B C*, in the point *G*; so that if the eye be at *G*, it should see *E*, and *E*, would reflect upon the third *Glasse* in the point *H*, and the eye that is at *L*, will see the *Image* that is at *E*. in the point of the *Catheti*: which *Image* shall come to the eye of the suspicious, *viz.* at *L*. by helpe of the third *Glasse*, upon which is made the second reflexion, and so brings unto the eye the object, though a wall be betweene it.



Corolaire. 1.

BY this invention of reflexions the assiegents of a *Towne* may be seene upon the *Rampart*: notwithstanding the *Parapet*; which the asseiged may doe by placing a *Glasse* in the hollow of the *Ditch*, and placing another upon the toppe of the wall, so that the line of *incidence* comming to the bottome of the *Ditch*, make an Angle equall to the Angle of *reflexion*, then by this scituation and *reflexion*, the *Image* of the asseigment will bee seene to him that is upon the *Rampart*.

Corolaire. 2.

BY which also may bee inferred, that the same reflexions may bee seene in a *Regular Polygon*, and placing as many *Glasses* as there are sides, counting two for one; for then the object being set to one of the *Glasses*, and the eye in the other, the *Image* will be seene easily.

Corolaire. 3.

FArther, notwithstanding the interposition of many *Walls*, *Chambers*, or *Cabinets*, one may see that which passeth through the most remotest of them, by placing of many *Glasses* as there are openings in the *walls*, making them to receive the incident Angles equall: that is, placing them in such sort by some *Geometricall* assistant, that the incident points may meete in the middle of the *Glasses:* but here all the defect will be, that the *Images* passing by so many reflexions, will be very weake and scarce observable.

PROBLEM. LXXIX.

How with a Musket to strike a marke, not looking towards it, as exact as one aymed at it.

AS let the eye be at *O*, and the marke *C*; place a plaine *Glasse* perpendicular as *A B:* so the marke *C* shall bee seene in *Catheti C A*, viz.

erpendicular upon a wall, are more violent han theſe which ſtrikes byaſ-wiſe or glaun-ngly.

But conſidering the ſtrength of the blow on-y, the *Queſtion* is moſt true, and often experi-nented to be found true: a Peece mounted at he beſt of the *Randon*, which is neare halfe of he right, conveyes her Bullet with a farre reater violence than that which is ſhot at, *oint blanke* or mounted paralell to the *Hori-on.*

The cõmon reaſon is, that ſhooting high, the *re* carries the *bowle* a longer time in the *aire*, nd the *aire* moves more facill upwards, than ownewards, becauſe that the *ayrie circles* that he motion of the *bullet* makes are ſooneſt bro-en. Howſoever this be the generall tenet, it s curious to find out the inequallity of moving f the *aire*; whether the *Bullet* fly upward, ownewarᵈ, or right forward, to produce a ncible difference of motion: and ſome thinke hat the *Cannon* being mounted, the *Bullet* preſ-ng the *Powder* maketh a greater reſiſtance, and causeth all the *Powder* to be inflamed before he *Bullet* is throwne out, which makes it to be ore violent than otherwiſe it would be. Vhen the *Cannon* is otherwiſe diſpoſed, the ontrary arives, the *fire* leaves the *Bullet*, and nd the *Bullet* rouling from the *Powder* reſiſts ſſe: and it is uſually ſeene, that ſhooting out f a *Musket* charged onely with *Powder*; to hoote to a marke of *Paper* placed *Point blanke*, hat there are ſeene many ſmall holes in the

paper,

paper, which cannot be other than the graine of *Powder* which did not take *fire*: but thi latter accident may happen from the overchar ging of the *Peece*, or the length of it, or windy or dampeneſſe of the *Powder*.

From which ſome may thinke, that a *Cannon* pointed right to the *Zenith*, ſhould ſhoote with greater violence, than in any other mount o forme whatſoever: and by ſome it hath been imagined, that a *Bullet* ſhot in this faſhion hath beene conſumed, melt, and loſt in the *aire*, by reaſon of the violence of the *blow*, and the acti vitie of the *fire*; and that ſundry experiment hath beene made in this nature, and the *Bulle* never found. *But* it is hard to beleeve this a ſertion: it may rather be ſuppoſed that the *Bul let* falling farre from the *Peece* cannot be diſcer ned where it falls: and ſo comes to be loſt.

4. *In the fourth place it may be asked, whether the diſcharge of a Cannon be ſo much the greater, by how much it is longer.*

IT ſeemeth at the firſt to bee moſt true, tha the longer the *Peece* is, the more violent i ſhootes: and to ſpeake generally, that which i direction by a *Trunke*, *Pipe*, or other concavi tie, is conveyed ſo much the more violent, o better, by how much it is longer; either in re ſpect of the *ſight*, *hearing*, *water*, *fire*, *&c.* and the reaſon ſeemes to hold in *Cannons*, becauſe in theſe that are long, the *fire* is retained a lon ger time in the concavitie of the *Peece*, and ſo throwe

throwes out the *Bullet* with more violence; and experience lets us see that taking *Cannons* of the same boare, but of diversitie of length from 8 foote to 12; that the *Cannon* of 9 foote long hath more force than that of 8 foot long, and 10 more than that of 9, and so unto 12 foote of length. Now the usuall *Cannon* carries 600 *Paces*, some more, some lesse; yea, some but 200 *Paces* from the *Peece*, and may shoote into soft earth 15 or 17 foote, into sand or earth which is loose, 22 or 24 foote; and in firme ground, about 10 or 12 foot, &c.

It hath beene seene lately in *Germany*, where there was made *Peeces* from 8 foote long to 17 foote of like boare, that shooting out of any *Peece* which was longer than 12 foote; the force was diminished, and the more in length the *Peece* increaseth, the lesse his force was; therefore the length ought to bee in a meane measure; and it is often seene, the greater the *Cannon* is, by so much the service is greater: but to have it too long or too short, is not convenient, but a meane proportion of length to bee taken; otherwise the flame of the *fire* will bee overpressed with *aire*: which hinders the motion in respect of substance, and distance of getting out,

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PRO-

PROBLEM. LXXXIIII.

Of prodigious progression and multiplication, of Creatures, Plants, Fruites, Numbers, Gold, Silver, &c. when they are alwayes augmented by certaine proportion.

HEre we shall shew things no lesse admirable, as recreative, and yet so certaine and easie to be demonstrated, that there needes not but *Multiplication* only, to try each particular: and first,

Of graines of Mustard-seed.

FIrst, therefore it is certaine that the increase of one graine of *Mustard-seed* for 20 *yeares* space, cannot bee contained within the visible world, nay if it were a hundred times greater than it is: and holding nothing besides from the Center of the *earth* even unto the *firmament*, but onely small graines of *Mustard-seed*. Now because this seemes but words, it must be proved by *Art*; as may bee done in this wise, as suppose one *Mustard-seed* sowne to bring forth a tree or branch, in each extendure of which might be a thousand graines: but we will suppose onely a thousand in the whole tree, and let us proceed to 20 *yeares*, every seed to bring forth yearely a thousand graines; now multiplying alwayes by a thousand, in lesse then 17 *years* you

you shall have so many graines which will surpasse the *sands*, which are able to fill the whole *firmament*: for following the supposition of *Archimedes*, and the most probable opinion of the greatnesse of the *firmament* which *Tico Brahe* hath left us; the number of graines of *sand* will be sufficiently expressed with 49 *Ciphers*, but the number of graines of *Mustard seed* at the end of 17 *yeares* will have 52 *Ciphers:* and moreover graines of *Mustard-seed*, are farre greater than these of the *sands*: it is therefore evident that at the seventeenth *yeare*, all the graines of *Mustard-seed*, which shall successively spring from one graine onely, cannot be contained within the limits of the whole *firmament*; what should it be then, if it should bee multiplyed againe by a thousand for the 18 *yeare:* and that againe by a thousand for every *yeares* increase untill you came to the 20 *yeare?* its a thing as cleare as the day, that such a heap of *Mustard-seed* would be a hundred thousand times greater than the *earth*: and being onely but the increase of one graine in 20 *yeares*.

Of Pigges.

Secondly, is it not a strange proposition, to say that the great *Turke* with all his *Revenues*, is not able to maintaine for one *yeares* time, all the *Pigges* that a *Sow* may *pigge* with all her race, that is, the increase with the increase unto 12 yeares: this seemes impossible, yet it s most true; for let us suppose and put the case

that a *Sow* bring forth but 6, two *males*, and 4 *females*, and that each *female* shall bring forth as many every yeare, during the space of 12 yeares, at the end of the time there will be found above 33 *millions of Pigges*: now allowing a *crowne* for the maintenance of each *Pigge* for a yeare, (which is as little as may be, being but neare a halfe of a *farthing* allowance for each day;) there must bee at the least so many *crownes* to maintaine them, one a yeare, *viz.* 33 *millions*, which exceedes the *Turkes* revenue by much.

Of graines of Corne.

THirdly, it will make one astonished to thinke that a graine of *Corne*, with his increase successively for the space of 12 yeares will produce in grains 2441406250000000000000, which is able to load almost all the creatures in the world.

To open wch, let it be supposed that the first yeare one *graine* being sowed brings forth 50, (but sometimes there is seen 70, sometimes 100 fold) which graines sowen the next yeare, every one so produce 50, and so consequently the whole and increase to be sowen every yeare, untill 12 yeares bee expired, there will bee of increase the aforesaid prodigious summe of grains, *viz.* 2441406250000000000000, which will make a cubicall heape of 6258522 graines every way, which is more than a cubicall body of 31 miles every way: for allowing 40 graines

in

in length to each foote, the Cube would bee 156463 foot every way: from which it is evident that if there were two hundred thousand *Cities* as great as *London*, allowing to each 3 *miles* square every way, and 100 foot in height, there would not bee sufficient roome to containe the aforesaid quantitie of *Corne:* and suppose a bushell of *Corne* were equall unto two Cubicke feete, which might containe twenty hundred thousand graines, then would there be 1220704625000000 bushells, and allowing 30 bushells to a *Tunne*, it would bee able to loade 813803083 vessells, which is more than eight thousand one hundred and thirty eigh millions, shippe loadings of 500 *Tunne* to each shippe: a quantitie so great that the Sea is scarce able to beare, or the universall world able to finde vessells to carry it: And if this *Corne* should bee valued at halfe a crowne the *bushell*, it would amount unto 1525880781250000 *pounds sterling*, which I thinke exceedes all the *Treasures* of all the *Princes*, and of other particular men in the whole *world:* and is not this good husbandry to sowe one graine of *Corne*, and to continue it in sowing, the increase onely for 12 yeares to have so great a profit.

Of the increase of Sheepe.

FOurthly, those that have great flockes of *Sheepe* may bee quickly rich if they would preserve their *Sheepe* without killing or selling of them: so that every *Sheepe* produce one each

yeare, for at the end of 16 yeares, 100 *Sheepe* will multiply and increase unto 61689 00, which is above 60 *millions*, and 16 *hundred thousand Sheepe*: now supposing them worth but a *crowne* a peece, it would amount unto 1542400 *pounds sterling*, which is above 15 *millions, and foure hundred and twenty thousand pounds*, a faire increase of one *Sheepe*: and a large portion for a *Childe* if it should bee allotted.

Of the increase of Cod-fish, Carpes, &c.

Fiftly, if there be any *creatures* in the world that doth abound with increase or fertilitie, it may be rightly attributed to *fish*; for they in their kindes produce such a great multitude of *egges*, and brings forth so many little ones, that if a great part were not destroyed continually, within a little while they would fill all the *Sea*, *Ponds*, and *Rivers* in the world; and it is easie to shew how it would come so to passe, onely by supposing them to increase without taking or destroying them for the space of 10 or 12 yeares: having regard to the soliditie of the *waters* which are allotted for to lodge and containe these *creatures*, as their bounds and place of rest to live in.

Of the increase and multiplication of men.

Sixtly, there are some that cannot conceive how it can be that from eight *persons* (which

was

was saved after the *deluge* or *Noahs flood*) should spring such a world of people to begin a Monarchie under *Nimrod*, being but 200 *yeares* after the *flood*, and that amongst them should be raised an *army of two hundred thousand fighting Men:* But it is easily proved if we take but one of the Children of *Noah*, and suppose that a new *generation* of people begun at every 30 yeares, and that it be continued to the seventh *generation* which is 200 *yeares*; for then of one onely *family* there would bee produced *one hundred and eleven thousand soules, three hundred and five* to begin the *world:* though in that time men lived longer, and were more capable of multiplication and increase: which number springing onely from a simple production of one yearely, would be farre greater; if one man should have many wives, which in ancient times they had: from which it is also that the *Children of Israel*, who came into *Egypt* but onely 70 *soules*, yet after 210 yeares captivitie, they came forth with their hostes; that there was told *sixe hundred thousand fighting men*, besides old people, *women* and *children*; and he that shall separate but one of the *families* of *Ioseph*, it would bee sufficient to make up that number: how much more should it bee then if wee should adjoyne many *families* together?

Of the increase of numbers.

SEventhly, what summe of money shall the Citie of *London* bee worth, if it should bee sold, and the mony be paid in a yeare after this

manner: the first *weeke* to pay a *pinne*, the second *weeke* 2 *pinnes*, the third *weeke* 4 *pinnes*, the fourth *weeke* 8 *pinnes*, the fift *weeke* 16 *pinnes*: and so doubling untill the 52 *weekes*, or the yeare be expired.

Here one would thinke that the value of the *pinnes* would amount but to a small matter, in comparison of the *Treasures*, or *riches* of the whole *Citie*: yet it is most probable that the number of *pinnes* would amount unto the sum of 4519599628681215, and if we should allow unto a quarter a hundred thousand *pinnes*, the whole would containe nintie eight millions, foure hundred thousand Tunne: which is able to loade 45930 *Shippes* of a thousand *Tunne* a peece: and if wee should allow a thousand *pinnes* for a penny, the summe of money would amount unto above *eighteene thousand, eight hundred and thirty millions* of *pounds sterling*, an high price to sell a *Citie* at: yet certaine, according to that first proposed. So if 40 *Townes* were sold upon condition to give for the first a *penny*, for the second 2 *pence*, for the third 4 *pence*, *&c.* by doubling all the rest unto the last, it would amount unto this number of *pence*, 1099511627775, which in *pounds* is 4581298444, that is foure thousand five hundred and fourescore millions of pounds and more.

Of

Of a man that gathered up Apples, Stones, or such like upon a condition.

Eighthly, admit there were an hundred *Apples*, *Stones*, or such like things that were placed in a straight line or right forme, a *pace* one from another, and a basket being placed a *pace* from the first: how many *paces* would there be made to put all these *Stones* into the basket, by fetching one by one: this would require neare halfe a day to doe it, for there would be made *tenne thousand and a hundred paces* before he should gather them all up.

Of Changes in Bells, in musicall Instruments, transmutation of places, in numbers, letters, men or such like.

Ninthly, is it not an admirable thing to consider how the skill of *numbers* doth easily furnish us with the knowledge of mysterious and hidden things, which simply looked into by others that are not versed in *Arithmeticke*, doe present unto them a world of confusion and difficultie.

As in the first place, it is often debated amongst our common *Ringers*, what number of *Changes* there might be made in 5, 6, 7, 8, or more *Bells*: who spend much time to answere their owne doubts, entering often into a *Labyrinth* in the serch thereof: or if there were 10 *voyces*, how many severall notes might there be?

be? These are propositions of such facillitie, that a child which can but multiply one number by another, may easily resolve it, which is but only to multiply every *number* from the unitie successively in each others product, unto the terme assigned: so the 6. *number* that is against 6. in the Table, is 720, and so many *Changes* may be made upon 6 *Bells*, upon 5 there are 120, *&c.*

In like manner against 10 in the Table is 3628800, that is, three millions, sixe hundred twenty eight thousand, eight hundred & foure-score: which shewes that 10 voyces may have so many consorts, each man keeping his owne note, but onely altering his place; and so of stringed *Instruments*: & the *Gamauth* may be varied according to which, answerable to the number against *X*, viz. 11240010750703996800000 notes, from which may be drawne this, or the like proposition.

Suppose that 7 *Schollers* were taken out of a free *Schoole* to bee sent to an *Universitie*, there to be entertained in some *Colledge* at commons for a certaine summe of money, so that each of them have two meales dayly, and no longer to continue there, that sitting all together upon one bench or forme at every meale, there might be a diverse transmutation of place, of account in some one of them, in comparison of another, and never the whole company to be twice alike in situation: how long may the *Steward* entertaine them? (who being not skilled in this fetch may answere unadvisedly.) It is most certaine that there will bee *five thousand and*

forty ſeverall poſitions or changings	1	*a* 1
in the ſeatings, which makes 7	2	*b* 2
years time not wanting 20 *dayes*:	6	*c* 3
Hence frō this mutabilitie of	24	*d* 4
tranſmutation, it is no marvell	120	*e* 5
that by 24 letters there ariſeth	720	*f* 6
and is made ſuch variety	5040	*g* 7
of *languages* in the *world*,	40320	*h* 8
and ſuch infinite number	362880	*i* 9
of *words* in each *lan-*	3628800	*k* 10
guage; ſeeing the di-	39916800	*l* 11
verſitie of *ſyllables*	479001600	*m* 12
produceth that ef-	6227020800	*n* 13
fect; and alſo by	87178291200	*o* 14
the interchange-	1307674368000	*p* 15
ing and placing	20922789888000	*q* 16
of *letters* a-	355687537996000	*r* 17
mongſt the	6402375683928000	*ſ* 18
vowels, and	121645137996300000	*t* 19
amongſt	2432902759?02640000	*u* 20
thēſelves	51090957957745440000	*w* 21
maketh	1124001075070399680000	*x* 22
theſe	25852024726619192640000	*y* 23
ſylla-	620448593438860623360000	*z* 24

bles: w^ch *alphabet* of 24 *letters* may be varied ſo many times, *vi.* 620448593438860623360000 which is *ſixe hundred twenty thouſand, foure hundred forty eight millions, five hundred ninety three thouſand, foure hundred thirty eight millions of millions*, and more.

Now allowing that a man may reade or ſpeake *one hundred thouſand words* in an *houre*, which is twice more words than there are contained

tained in the *Psalmes of David*, (a taske too great for any man to doe in so short a time) and if there were *foure thousand sixe hundred and fifty thousand millions of men*, they could not speake these words; (according to the hourely proportion aforesaid in *threescore and ten thousand yeares*; which variation and transmutation of letters, if they should bee written in *bookes*, allowing to each leafe 28000 words, (which is as many as possibly could bee inserted,) and to each booke a reame or 20 quire of the largest and thinnest printing paper; so that each book being about 15 *inches* long, 12 broad, and 6 thicke: the bookes that would be made of the transmutation of the 24 letters aforesaid, would bee at least 387780370899288: and if a *Library* of a *mile square* every way, of 50 foot high, were made to containe 250 *Galleries* of 20 foote broad a peece, it would containe *foure hundred millions* of the said *bookes*: so there must be to containe the rest no lesse than 96945092 such *Libraries*; and if the bookes were extended over the surface of the *Globe* of the *earth*, it would a decuple covering unto it: a thing seeming most incredible that 24 letters in their transmutation should produce such a prodigious number; yet most certaine and infallible in computation.

Of a Servant hired upon certaine conditions.

A *Servant* said unto his master, that hee would dwell with him all his life time, if he

he would but onely lend him land to sowe one gr[illegible]e of *Corne* with all his increase for 8 *yeares* time; how thinke you of this bargaine: for if he had but a quarter of an inch of ground for each graine, and each graine to bring forth *yearely* of increase 40 graines; the whole sum would amount unto, at the terme aforesaid, 6553600000000 graines: and seeing that *three thousand and sixe hundred millions of inches* doe but make *one mile square* in the superficies, it shall bee able to receive *fourteene thousand and foure hundred millions of graines*, which is 1440000000000: thus dividing the aforesaid 6553600000000, the *Quotient* will bee 455, and so many square miles of land must there be to sow the increase of one graine of *Corne* for 8 *yeares*, which makes at the least *foure hundred and twenty thousand Acres of land*, which rated but at five shillings the *Acre per Annum*, amounts unto *one hundred thousand pound*; which is *twelve thousand and five hundred pound a yeare*, to bee continued for 8 *yeares*; a pretty pay for *Master Servants* 8 *yeares service*.

PROBLEM. LXXXV.

Of Fountaines, Hydriatiques, Machinecke, and other experiments upon water, or other liquor.

1. *First how to make water at the foote of a mountaine to ascend to the top of it, and so to descend on the other side.*

TO doe this there must bee a *Pipe* of *lead*, which may come from the *Fountaine A*, to the top of the *Mountaine B*; and so to descend on the other side a little lower than the *Fountaine*, as at *C*: then make a hole in the *Pipe* at the toppe of the *Mountaine*, as at *B*, and stop the end of the *Pipe* at *A* and *C*; and fill this *Pipe* at *B* with water: and close it very carefully againe at *B*, that no aire get in: then unstop the end at *A*, and at *C*; then will the water perpetually runne up the hill, and descend on the other side, which is an invention of great consequence to furnish *Villages* that want water.

Figure 87.

2. *Secondly,*

2. *Secondly, how to know what wine or other liquor there is in a veſſell without opening the bung-hole, and without making any other hole, than that by which it runs out at the toppe.*

IN this *Probleme* there is nothing but to take a bowed pipe of *Glaſſe*, and put it into the *faucets hole*, and ſtopping it cloſe about: for then you ſhall ſee the *wine* or *liquor* to aſcend in this *Pipe*, untill it bee juſt even with the *liquor* in the *veſſell*; by which a man may fill the *veſſell*, or put more into it: and ſo if need were, one may empty one *veſſell* into another without opening the *bung-hole*.

3. *Thirdly, how is it that it is ſaid that a veſſell holds more water being placed at the foote of a Mountaine, than ſtanding upon the toppe of it.*

THis is a thing moſt certaine, becauſe that *water* and all other *liquor* diſpoſeth it ſelfe ſpherically about the Center of the *earth*; and by how much the *veſſell* is nearer the Center, by ſo much the more the ſurface of the *water* makes a leſſer *ſpheare*, and therefore every part more *gibbous* or ſwelling, than the like part in a greater *ſpheare*: and therefore when the ſame *veſſell* is farther from the Center of the *earth*, the ſurface of the *water* makes a greater *ſpheare*, and therefore leſſe *gibbous*, or ſwelling over the *veſſell*:

vessell: from whence it is evident that a *vessell* neare the Center of the *earth* holds more *water* than that which is farther remote from it; and so consequently a *vessell* placed at the bottome of the *Mountaine* holds more *water*, than being placed on the top of the *Mountaine:* First, therefore one may conclude, that one and the same *vessell* will alwayes hold more: by how much it is nearer the center of the *earth*. Secondly, if a *vessell* be very neare the Center of the earth, there will bee more *water* above the brims of it, than there is within the *vessell*. Thirdly, a *vessell* full of *water*

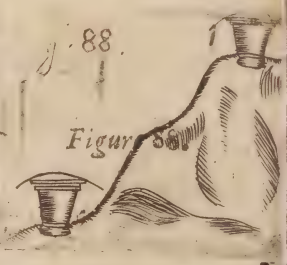


Figure 88.

comming to the Center will spherically increase, and by little and little leave the *vessell;* and passing the Center, the *vessell* will be all emptied. Fourthly, one cannot carry a Paile of *water* from a low place to a higher, but it will more and more run out and over, because that in ascending it lies more levell, but descending it swelles and becomes more *gibbous*.

4. *Fourthly, to conduct water from the toppe of one Mountaine, to the top of another.*

AS admit on the top of a *Mountaine* there is a spring, and at the toppe of the other *Mountaine*

Mountaine there are *inhabitants* which wants water: now to make a *bridge* from one *Mountaine* to another, were difficult and too great a charge; by way of *Pipes* it is easie and of no great price: for if at the *spring* on the toppe of the *Mountaine* be placed a *Pipe*, to descend into the valley, and ascend to the other *Mountaine*, the water will runne naturally, and continually, provided that the *spring* be somewhat higher than the passage of the water at the *inhabitants*.

5. *Fiftly, of a fine Fountaine which spouts water very high, and with great violence by turning of a Cocke.*

LEt there be a *vessell* as *A B*, made close in all his parts, in the middle of which let *C D* be a *Pipe* open at *D* neare the bottome, and then with a Squirt squirt in the water at *C*, stopped above by the *cocke* or *faucet C*, with as great violence as possible you can; and turne the *Cocke* immediately. Now there being an indifferent quantitie of *water* & *aire* in the *vessell*, the *water* keepes it selfe in the bottome, and the *aire* which was greatly pressed, seekes for more place, that

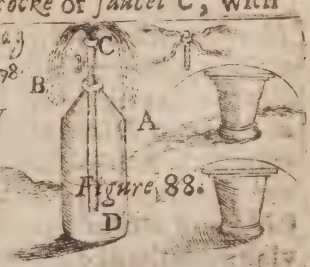


Figure 88.

turning the *cocke* the *water* issueth forth at the *Pipe*, and flyes very high; and that especially if the *vessell* bee a little heated: some make use of this for an *Ewer* to wash hands withall, and therefore putting a moveable *Pipe* above *C*, such as the figure sheweth: which the *water* will cause to turne very quicke, pleasurable to behold.

6. *Sixtly, of Archimedes screw, which makes water ascend by descending.*

THis is nothing else but a *Cylinder*, about the which is a *Pipe* in forme of a *screw*, and when one turnes it, the water descends alwaies in respect of the *Pipe*: for it passeth from one part which is higher to that which is lower, and at the end of the *engine* the water is found higher than it was at the spring. This great enginer admirable in all *Mathematicall Arts* invented this *Instrument* to wash *King Hieroies* great *vessells*, as some Authors sayes, also to water the fields of *Egypt*, as *Diodorus* witnesseth: and *Cardanus* reporteth that a Citizen of *Milan* having made the like *engine*, thinking himselfe to bee the first inventer, conceived such exceeding joy, that he became *foll.* 2.

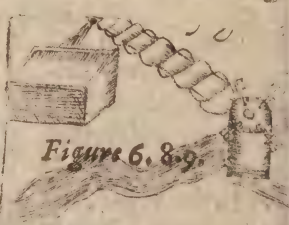


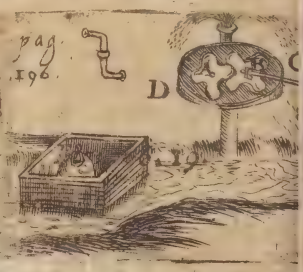
Figure 6, 8, 9.

Againe

Againe a thing may aſcend by deſcending, if a *ſpirall line* bee made having many *circulations* or revolutions; the laſt being alwayes leſſer than the firſt, yet higher than the Plaine ſuppoſed: it is moſt certaine that then putting a ball into it, and turning the *ſpirall line* ſo, that the firſt *circulation* may bee perpendicular, or touch alwayes the ſuppoſed Plaine: the ball ſhall in deſcending continually aſcend, untill at laſt it come to the higheſt part of the *ſpirall line*, & ſo fall out. And here eſpecially may be noted, that a moving body as *water*, or a *Bullet*, or ſuch like, will never aſcend if the *helicall revolution* of the ſcrew be not inclining to the *Horizon*: ſo that according to this inclination the ball or liquor, may deſcend alwayes by a continuall motion and revolution. And this experiment may be more uſefull, naturally made with a threed of *iron*, or *latine* turned or bowed *helically* about a *Cylinder*, with ſome diſtinction of diſtances betweene the *Helices*; for then having drawne out the *Cylinder*, or having hung or tied ſome weight at it in ſuch ſort, that the water may eaſily drop if one lift up the ſaid thred: theſe *helices* or revolutions, notwithſtanding will remaine inclining to the *Horizon*, and then turning it about forward, the ſaid weight will aſcend, but backward it will deſcend. Now if the revolutions bee alike, and of equallitie amongſt themſelves; and the whirling or turning motion be quicke, the ſight will be ſo deceived, that producing the action it will ſeeme to the ignorant no leſſe than a *miracle*.

7. *Seventhly, of another fine Fountaine of pleasure.*

THis is an *engine* that hath two wheeles with *cogges*, or *teeth* as *A B*, which are placed within an *Ovall C D*, in such sort, that the *teeth* of the one, may enter into the *notches* of the other; but so just that neither *aire* nor *water* may enter into the *Ovall* coffer, either by the middle or by the sides, for the wheele must joyne so neare to the sides of the coffer, that there be no vacuitie: to this there is an axeltree with a handle to each wheele, so that they may be turned, and *A* being turned, that turneth the other wheele that is opposite: by which motion the *aire* that is in *E*, and the *water* that is carried by the hollow of the wheeles of each side, by continuall motion, is constrained to mount and flie out by the funnell *F*: now to make the water runne what way one would have it, there may be applyed upon the toppe of the *Pipe F*, two other moveable *Pipes* inserted one within another; as the figure sheweth. But here note that there may accrue some inconveniency in this *machanicke*, seeing that by quicke turning the *cogges*



or

or *teeth* of the wheeles running one against another, may neare breake them, and so give way to the *aire* to enter in, which being violently inclosed will escape to occupie the place of the *water*, whose weight makes it so quicke: howsoever, if this *Machine* be curiously made as an able workeman may easily doe, it is a most soveraigne *engine*, to cast water high and farre off for to quench fires. And to have it to raine to a place assigned, accommodate a socket having a *Pipe* at the middle, which may point towards the place being set at the top thereof, and so having great discretion in turning the Axis of the wheele, it may worke exceeding well, and continue long.

8. *Eightly, of a fine watering potte for gardens.*

THis may be made in forme of a *Bottle* according to the last figure or such like, having at the bottome many small holes, & at the necke of it another hole somewhat greater than these at the bottome, which hole at the toppe you must unstop when you would fill this watering *pot*, for then it is nothing but putting the lower end into a paile of water, for so it will fill it selfe by degrees: and being full, put your thumbe on the hole at the necke to stop it, for then may you carry it from place to place, and it will not sensibly runne out, yet something will if it were so close stopped, and all in time contrary to to the ancient tenet in *Philosophy*, that *aire* will not penetrate.

9 *Ninthly, how easily to take wine out of a vessell at the bung-hole, without piercing of a hole in the vessell.*

IN this there is no need but to have a *Cane* or *Pipe* of *Glasse* or such like, one of the ends of which may be closed up almost, leaving some small hole at the end; for then if that end be set into the *vessell* at the bung-hole, the whole *Cane* or *Pipe* will bee filled by little and little, and once being full; stoppe the other end which is without: and then pull out the *Cane* or *Pipe*, so will it bee full of *wine*; then opening a little the toppe above, you may fill a *Glasse* or other *Potte* with it, for as the *wine* issueth out, the *aire* commeth into the *Cane* or *Pipe* to supply vacuity.

Figure 6.8.9. pag. 198

10. *Tenthly, how to measure irregular bodies by helpe of water.*

SOme throw in the *body* or *magnitude* into a *vessell*, and keepe that which floweth out over, saying it is alwayes equall to the thing cast into the *water*: but it is more neater this way to powre into a *vessell* such a quantity of *water*, which

which may be thought sufficient to cover the *body* or *magnitude*, and make a marke how high the water is in the *vessell*, then powre out all this water into another *vessell*, and let the *body* or *magnitude* be placed into the first *vessell*; then powre in water from the second *vessell*, untill it ascend unto the former marke made in the first *vessell*; so the water which remaines in the second *vessell*, is equall to the *body* or *magnitude* put into the water: but here note that this is not exact or free from error, yet nearer the truth than any *Geometrician* can otherwise possibly measure, and these *bodyes* that are not so full of powers are more truly measured this way, than others are.

11. *To finde the weight of water.*

SEeing that $\frac{574}{1000}$ part of an ounce weight, makes a cubicall inch of water: and every pound weight *Haverdepoise* makes 27 cubicall intches, and $\frac{2}{10}$ *fere*, and that 7 *Gallons* and a halfe wine measure makes a foote cubicall, it is easie by inversion, that knowing the quantitie of a *vessell* in *Gallons*, to finde his content in *cubicall feete* or weight: and that late famous *Geometrician Master Brigs* found a cubicall foote of *water* to weigh neare 62 pound weight *Haverdepoize*. But the late learned *Simon Stevin* found a *cubicall foote* of water to weigh 65 pound, which difference may arise from the inequallitie of water; for some waters are more ponderous than others, and some difference

may be from the weight of a pound, and the measure of a foote: thus the weight and quantitie of a solid foote settled, it is easie for *Arithmetitians* to give the contents of *vessells* or *bodies* which containe liquids.

12. *To finde the charge that a vessell may carry, as Shippes, Boates, or such like.*

THis is generally conceived, that a *vessell* may carry as much weight as that water weigheth, which is equall unto the *vessell* in bigneſſe, in abating onely the weight of the *vessell*: we see that a barrell of *wine* or *water* cast into the *water*, will not sinke to the bottome but swimme easily, and if a *Shippe* had not *iron* and other ponderosities in it, it might swimme full of *water* without sinking: in the same manner if the *vessell* were loaden with *lead*, so much should the *water* weigh: hence it is that *Marriners* calls *Shippes* of 50 thousand *Tunnes*, because they may containe one or two thousand *Tunne*, and so consequently carry as much.

13. *How comes it that a Shippe having safely sayled in the vaſte Ocean, and being come into the Port or harbour, without any tempeſt will sinke downe right.*

THe cause of this is that a *vessell* may carry more upon some kinde of *water* than upon other; now the *water* of the *Sea* is thicker and heavier than that of *Rivers*, *Wells*, or *Fountains*; there-

herefore the loading of a *veſſell* which is accounted ſufficient in the *Sea*, becomes too great in the *harbour* or ſweet *water*. Now ſome thinke that it is the depth of the *water* that makes *veſſells* more eaſie to ſwimme, but it is an abuſe; for if the loading of a *Shippe* bee no heavier than the *water* that would occupie that place, the *Ship* ſhould as eaſily ſwim upon that *water*, as if it did ſwim upon a thouſand fathom deepe of *water*; and if the *water* be no thicker than a leafe of *paper*, and weigheth but an ounce under a heavy body, it will ſupport it, as well as if the *water* under it weighed ten thouſand pound weight: hence it is if there be a *veſſell* capable of a little more than a thouſand pound weight of *water*, you may put into this *veſſell* a peece of *wood*, which ſhall weigh a thouſand pound weight; (but lighter in his kinde than the like of magnitude of *water*:) for then powring in but a quarte of *water* or a very little quantitie of *water*, the *wood* will ſwimme on the top of it, (provided that the *wood* touch not the ſides of the *veſſell*:) which is a fine experiment, and ſeemes admirable in the performance.

14. *How a groſſe body of mettle may ſwimme upon the water.*

THis is done by extending the mettle into a thinne *Plate*, to make it hollow in forme of a *veſſell*; ſo that the greatneſſe of the *veſſell* which the *aire* with it containeth, be equall to the

the magnitude of the *water*, which weighes as much as it; for all bodies may swimme without sinking, if they occupie the place of *water* equall in weight unto them, as if it weighed 12 pound, it must have the place of 12 pound of *water*: hence it is that wee see floating upon the *water* great *vessells* of *Copper* or *Brasse*, when they are hollow in forme of a *Chaldron*. And how can it be otherwise conceived of *Ilands* in the *Sea* that swimme and floate? is it not that they are hollow and some part like unto a *Boate*, or that their *earth* is very light and spongeous, or having many concavities in the body of it, or much *wood* within it.

And it would bee a pretty proposition to shew how much every kinde of *mettle* should bee inlarged, to make it swimme upon the *water*: which doth depend upon the proportions that is betweene the weight of the *water* and each *mettle*. Now the proportion that is betweene *mettles* and water of equall magnitude, according to some Authors is as followeth.

A magnitude of 10 pound weight of water will require for the like magnitude of

Gould.	187 1/2
Lead.	116 1/2
Silver.	104
Copper.	91
Iron.	81
Tinne.	75

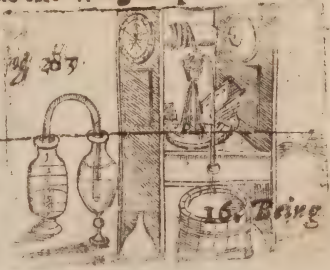
From which is inferred, that to make a peece of *Copper* of 10 pound weight to swimme, it must bee so made hollow, that it may hold 9 times that weight of *water* and somewhat more, that is to say, 91 pound: seeing that *Copper*

per and *water* of like magnitudes in their ponderosities, are as before, as 10 to 91.

15. *How to weigh the lightnesse of the aire.*

PLace a *Ballance* of wood turned upside downe into the *water*, that so it may swim, then let *water* be inclosed within some body, as within a *Bladder* or such like; and suppose that such a quantitie of *aire* should weigh one pound, place it under one of the *Ballances*, and place under the other as much weight of lightnesse as may counter-ballance and keepe the other *Ballance* that it rise not out of the *water*: by which you shall see how much the lightnesse is.

But without any *Ballance* doe this; take a Cubicall hollow *vessell*, or that which is *Cylindricall*, which may swimme on the *water*, and as it sinketh by placing of weights upon it, marke how much; for then if you would examine the weight of any body, you have nothing to doe but to put it into this *vessell*, and marke how deepe it sinkes; for so many pound it weighes as the weights put in doth make it so to sinke.



16. *Being*

16. *Being given a body, to marke it about, and shew how much of it will sinke in the water, or swimme above the water.*

THis is done by knowing the weight of the *body* which is given, and the quantitie of *water*, which weighes as much as that *body*; for then certainely it will sinke so deepe, untill it occupieth the place of that quantitie of *water*.

17. *To finde how much severall mettle or other bodies doe weigh lesse in the water than in the aire.*

TAke a *Ballance* and weigh (as for example) 9 pound of *Gould*, *Silver*, *Lead*, or *Stone* in the *aire*, so it hang in *æquilibrio;* then comming to the water, take the same quantitie of *Gould*, *Silver*, *Lead*, or *Stone*, and let it softly downe into it, and you shall see that you shall neede a lesse counterpoise in the other *Ballance* to counter-ballance it: wherefore all *solids* or *bodyes* weigh lesse in the *water* than in the *aire*, and so much the lesse it will be, by how much the *water* is grosse and thicke, because the weight findes a greater resistance, and therefore the *water* supports more than *aire:* and further, because the *water* by the ponderositie is displeased, and so strives to be there againe, pressing to it, by reason of the other *waters* that are about it, according to the proportion of his

his weight. *Archimedes* demonſtrateth, that all bodies weigh leſſe in the *water* (or in like *liquor*) by how much they occupie place: and if the *water* weigh a pound weight, the magnitude in the *water* ſhall weigh a pound leſſe than in the *aire*.

Now by knowing the proportion of *water* and *mettles*, it is found that *Gould* loſeth in the *water* the 19 part of his waight: *Copper* the 9 part, *Quickeſilver* the 15 part, *Lead* the 12 part, *Silver* the 10 part, *Iron* the 8 part, *Tinne* the 7 part and a little more: wherefore in materiall and abſolute weight, *Gould* in reſpect of the *water* that it occupieth weigheth 18, and $\frac{3}{4}$ times heavier than the like quantitie of *water*, that is, as 18 $\frac{3}{4}$ to the *Quickeſilver* 15 times: *Lead* 11 and $\frac{3}{5}$, *Silver* 10 and $\frac{2}{7}$, *Copper* 9 and $\frac{1}{10}$, *Iron* 8 and $\frac{1}{2}$, and *Tinne* 8 and $\frac{1}{2}$. Contrarily in reſpect of greatneſſe, if the *water* be as heavy as the *Gould*, then is the *water* almoſt 19 times greater than the magnitude of the *Gould*, and ſo may you judge of the reſt.

18. *How is it that a ballance having like weight in each ſcale, and hanging in æquilibrio in the aire: being placed in another place, (without removing any weight) it ſhall ceaſe to hang in æquilibrio ſencibly: yea by a great difference of weight.*

THis is eaſie to be reſolved by conſidering different *mettles*, which though they weigh

weigh equall in the *aire*, yet in the water there will bee an apparant difference; as suppose so that in the scale of each *Ballance* be placed 18 pound weight of severall *mettles*, the one *Gould* and the other *Copper*, which being in *aquilibrio* in the *aire*, placed in the *water*, will not hang so, because that the *Gould* loseth neare the 18 part of his weight, which is about 1 pound, and the *Copper* loseth but his 9 part, which is 2 pound: wherefore the *Gold* in the *water* weigheth but 17 pound, and the *Copper* 16 pound, which is a difference most sencible to confirme that point.

19. *To shew what waters are heavier one than another, and how much.*

Physitians have an especiall respect unto this, judging that *water* which is lightest is most healthfull and medicinall for the body; and *Sea-men* know that the heaviest *waters* doe beare most, and it is knowne which *water* is heaviest thus. Take a peece of *waxe* and fasten *lead* unto it, or some such like thing that it may but precisely swimme, for then it is equall to the like magnitude of *water*; then put it into another *vessell* which hath contrary *water*, and if it sinke, then is that *water* lighter than the other: but if it sinke not so deepe, then it argueth the *water* to be heavier or more grosser than the first *water*; or one may take a peece of *wood*, and marke the quantitie of sinking of it into severall *waters*, by which you

may

may judge which is lighteſt or heavieſt, for in that which it ſinkes moſt, that is infallibly the lighteſt; and ſo contrarily.

20. *How to make a Pound of water weigh as much as* 10, 20, 30, *or a hundred pound of Lead; nay as much as a thouſand, or ten thouſand pound weight.*

THis propoſition ſeemes very impoſſible, yet *water* incloſed in a *veſſell*, being conſtrained to dilate it ſelfe, doth weigh ſo much as though there were in the concavitie of it a ſollid body of *water*.

There are many wayes to experiment this propoſition, but to verifie it, it may be ſufficient to produce two excellent ones onely: which had they not beene really acted, little credit might have beene given unto it.

The firſt way is thus: Take a *Magnitude* which takes up as much place as a *hundred* or a *thouſand pound* of *water*, & ſuppoſe that it were tied to ſome thing that it may hang in the *aire*; then make a *Ballance* that one of the *ſcales* may inviron it, yet ſo that it touch not the ſides of it: but leave ſpace enough for one pound of *water*: then having placed 100 pound weight in the other *ſcale*, throw in the *water* about the *Magnitude*, ſo that one pound of *water* ſhall weigh downe the hundred pound in the other *Ballance*.

The ſecond way is yet more admirable: take a common *Ballance* that is capable to receive

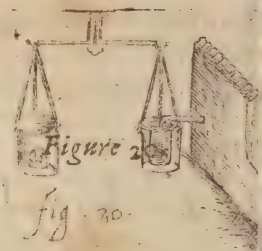


Figure 20
fig. 20.

10 or 20 pound of *water*, then put into it a *magnitude* which may take up the place of 9 or 19 pound of *water*, which must bee hung at some *Iron* or *beame* which is placed in a *wall*; so that it hang quiet: (now it is not materiall whether the *magnitude* be hollow or massie) so that it touch not the *Ballance* in which it is put: for then having put the *lead* or weight into the other *Ballance*, powre in a pound of *water* into the *Ballance* where the *magnitude* is, and you shall see that this one pound of *water* shall counterpoise the 10 or 20 pound of *lead* which is set in the other *Ballance*.

Problem. LXXXVI.

Of sundry Questions of Arithmeticke, and first of the number of sands.

It may be said incontinent, that to undertake this were impossible, either to number the *sands* of *Libya*, or the *sands* of the *Sea*; and it was this that the *Poets* sung, and that which the vulgar beleeves; nay, that which long agoe certaine *Philosophers* to *Gelon King of Sicily*

ly reported, that the graines of *sand* were innumerable: But I answere with *Archimedes*, that not onely one may number these which are at the border and about the *Sea*; but these which are able to fill the whole world: if there were nothing else but *sand*, and the graines of *sands* admitted to bee so small, that 10 may make but one graine of *Poppy*: for at the end of the account there neede not to expresse them, but this number 30840979456, and 35 *Ciphers* at the end of it, *Clavius* and *Archimedes* makes it somewhat more; because they make a greater firmament than *Tycho Brahe* doth; and if they augment the Vniverse, it is easie for us to augment the number, and declare assuredly how many graines of *sand* there is requisite to fill another world, in comparison that our visible world were but as one graine of *sand*, an atome or a point; for there is nothing to doe but to multiply the number by it selfe, which will amount to ninety places, whereof twenty are are these, 95143798134910955936, and 70 *Ciphers* at the end of it: which amounts to a most prodigious number, and is easily supputated: for supposing that a graine of *Poppy* doth containe 10 graines of *sand*, there is nothing but to compare that little bowle of a graine of *Poppy*, with a bowle of an inch or of a foote, and that to be compared with that of the *earth*, and then that of the *earth* with that of the *firmament*; and so of the rest.

2. *Divers mettles being melted together in one body, to finde the mixture of them.*

THis was a notable invention of *Archimedes*, related by *Vtrivious* in his *Architecture*, where he reporteth that the *Gould-smith* which *King Hiero* imployed for the making of the *Goulden Crowne*, which was to be dedicated to the *gods*, had stolen part of it and mixed *Silver* in the place of it: the *King* suspicious of the worke proposed it to *Archimedes*, if by Art he could discover without breaking of the *Crowne*, if there had beene made mixture of any other mettle with the *Gould*. The way which he found out was by bathing himselfe, for as hee entred into the *vessell* of *water*, (in which he bathed himselfe) so the *water* ascended or flew out over it, and as hee pulled out his body the *water* descended: from which he gathered that if a Bowle of pure *Gould*, *Silver*, or other mettle were cast into a *vessell* of *water*, the *water* proportionally according to the thing cast in would ascend; and so by way of *Arithmeticke* the question lay open to bee resolved: who being so intensively taken with the invention, leapes out of the *Bath* all naked, crying as a man transported, *I have found*, *I have found*, and so discovered it.

Now some say that he tooke two *Masses*, the one of pure *Gould*, and the other of pure *Silver*, each equall to the weight of the *Crowne*, and therefore unequall in magnitude or greatnesse;

and

and then knowing the severall quantities of *water* which was answerable to the *Crowne*, and the severall *Masses*, he subtilly collected, that if the *Crowne* occupied more place within the water than the *Masse* of *Gould* did: it appeared that there was *Silver* or other mettle melt with it. Now by the rule of position, suppose that each of the three *Masses* weighed 18 pound a peece, and that the *Masse* of *Gold* did occupie the place of one pound of *water*, that of *Silver* a pound and a halfe, and the *Crowne* one pound and a quarter only: then thus he might operate: the *Masse* of *Silver* which weighed 18 pounds, cast into the *water*, did cast out halfe a pound of *water* more than the *Masse* of *Gould*, which weighed 18 pound; and the *Crowne* which weighed also 18 pound, being put into a *vessell* full of *water*, threw out more *water* than the *Masse* of *Gold* by a quarter of a pound, (because of mixt mettle which was in it:) therefore by the rule of proportion, if halfe a pound of *water* (the excesse) be answerable to 18 pound of *Silver*, one quarter of a pound of excesse shall be answerable to 9 pound of *Silver*, and so much was mixed in the *Crowne*.

Some judge the way to bee more facill by weighing the *Crowne* first in the *aire*, then in the *water*; in the *aire* it weighed 18 pound, and if it were pure *Gould*, in the *water* it would weigh but 17 pound; if it were *Copper* it would weigh but 16 pound; but because wee will suppose that *Gould* and *Copper* is mixed together, it will weigh lesse then 17 pound,

yet more than 16 pound, and that according to the proportion mixed: let it then be supposed that it weighed in the *water* 16 pound and 3 quarters, then might one say by proportion, if the difference of one pound of losse, (which is betweene 16 and 17) bee answerable to 18 pound, to what shall one quarter of difference be answerable to, which is betweene 17 and 16 ¾, and it will be 4 pound and a halfe; and so much *Copper* was mixed with the *Gould*.

Many men have delivered sundry wayes to resolve this proposition since *Archimedes* invention, and it were tedious to relate the diversities.

Baptista Benedictus amongst his *Arithmeticall Theoremes*, delivers his way thus: if a *Masse* of *Gold*, of equall bignesse to the *Crowne* did weigh 20 pound, and another of *Silver* at a capacitie or bignesse at pleasure, as suppose did weigh 12 pound, the *Crowne* or the mixt body would weigh more than the *Silver*, and lesser than the *Gould*; suppose it weighed 16 pound which is 4 pound lesse than the *Gould* by 8 pound, then may one say, if 8 pound of difference come from 12 pound of *Silver*, from whence comes 4 pound which will be 6 pound, and so much *Silver* was mixed in it, *&c.*

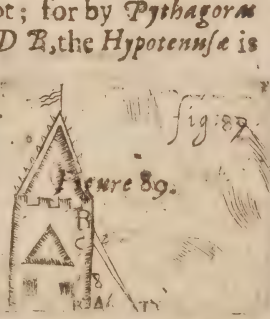
2. *Three*

3. *Three men bought a quantitie of wine, each paid alike, and each was to have alike; it happened at the last partition that there was 21 Barrells, of which 7 were full, 7 halfe full, and 7 empty, how must they share the wine and vessells, that each have as many vessells one as another, & as much wine one as another.*

THis may be answered two wayes as followeth, and these numbers 2, 2, 3; or 3, 3, 1, may serve for direction, and signifies that the first person ought to have 3 *Barrells* full, & as many empty ones, and one which is halfe full; so hee shall have 7 *vessells* and 3 *Barrels*, and a halfe of liquor: and one of the other shall in like manner have as much, so there will remaine for the third man 1 *Barrell* full, 5 which are halfe full, and 1 empty, and so every one shall have alike both in *vessells* and *wine*. And generally to answere such questions, divide the number of *vessells* by the number of persons, and if the *Quotient* be not an intire number, the question is impossible; but when it is an intire number, there must be made as many parts as there are 3 persons, seeing that each part is lesse than the halfe of the said *Quotient:* as dividing 21 by 3 there comes 7 for the *Quotient*, which may be parted in these thre parts, 2, 2, 3, or 3, 3, 1, each of which being lesse than halfe of 7.

4. *There is a Ladder which ſtands upright againſt a wall of* 10 *foote high; the foot of it is pulled out* 6 *foote from the wall upon the pavement: how much hath the top of the Ladder deſcended.*

THe anſwere is, 2 foot; for by *Pythagoras* rule the ſquare of *D B*, the *Hypotenuſe* is equall to the ſquare of *D A* 6, and *A B* 10. Now if *D A* bee 6 foot, and *A B* 10 foot, the ſquares are 36 and 100, which 36 taken from 100 reſts 64, whoſe *Roote-quadrat* is 8; ſo the foot of the *Ladder* being now at *D*, the toppe will bee at *C*, 2 foote lower than it was when it was at *B*.



PROBLEM. LXXXVII.

Witty ſuits or debates betweene Caius and Sempronius, upon the forme of figures; which Geometricians call Iſoperimeter, or equall in circuit or compaſſe.

MArvell not at it if I make the *Mathematickes* take place at the Barre, and if I ſet forth

forth here *Bartolus*, who witnesseth of himselfe, that being then an ancient Doctor in the Law, he himselfe tooke upon him to learne the elements and principles of *Geometry*, by which he might set forth certaine *Lawes* touching the divisions of *Fields*, *Waters*, *Ilands*, and other incident places: now this shall be to shew in passing by, that these sciences are profitable and behovefull for *Iudges*, *Counsellors*, or such, to explaine many things which falles out in *Lawes*, to avoid ambiguities, contentions, and suits often.

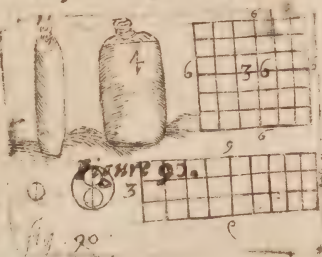


Figure 93.

1. *Incident.*

Caius had a *field* which was directly square, having 24 measures in Circuit, that was 6 on each side: *Sempronius* desiring to fit himselfe, prayed *Caius* to change with him for a *field* which should bee equivalent unto his; and the bargaine being concluded, he gave him for counterchange a peece of ground which had just as much in circuit as his had; but it was not square, yet *Quadrangular* and *Rectangled* having 9 measures in length for each of the two longest sides, and 3 in bredth for each shorter side: Now *Caius* which was not the most sub-

tilleſt nor wiſeſt in the world excepted his bargaine at the firſt, but afterwards having conferred with a *Land meaſurer* and *Mathematitian*, found that he was overreached in his bargaine, and that his field contained 36 ſquare meaſures, and the other field had but 27 meaſures, (a thing eaſie to be knowne by multiplying the length by the bredth:) *Sempronius* conteſted with him in ſuite of *Law*, and argued that figures which have equall *Perimeter* or *circuit*, are equall amongſt themſelves: my field, ſaith he, hath equall *circuit* with yours, therefore it is equall unto it in quantitie. Now this was ſufficient to delude a *Iudge* which was ignorant in *Geometricall* proportions, but a *Mathematician* will eaſily declare the deceit, being aſſured that figures which are *Iſoperimeter*, or equall in *circuit*, have not alwayes equall capacitie or quantitie: ſeeing that with the ſame *circuit*, there may bee infinite figures made which ſhall be more and more capable, by how much they have more Angles, equall ſides, and approach nearer unto a *circle*, (which is the moſt capableſt figure of all,) becauſe that all his parts are extended one from another, and from the middle or Center as much as may be: ſo we ſee by an infallible rule of experience, that a ſquare is more capable of quantitie than a *Triangle* of the ſame *circuit*, and a *Pentagone* more than a *ſquare*, and ſo of others, ſo that they be *regular figures* that have their ſides equall, otherwiſe there might be that a regular *Triangle*, having 24 meaſures in *circuit* might

might have more capacitie than a rectangled *Parallelogram* which had also 24 measures of *circuit*, as if it were 11 in length and 1 in breadth, the *circuit* is still 24; yet the quantitie is but 11: and if it had 6 every way, it gives the same *Perimeter, viz.* 24. but a quantitie of 36 as before.

2. *Incident.*

Sempronius having borrowed of *Caius* a sacke of *Corne*, which was 6 foot high and 2 foote broad, and when there was question made to repay it, *Sempronius* gave *Caius* backe two sackes full of *Corne*, which had each of them 6 foot high and 1 foot broad: who beleeved that if the sackes were full hee was repaid, and it seemes to have an appearance of truth barely looked on. But it is most evident in demonstration, that the two sackes of *Corne* paid by *Sempronius* to *Caius*, is but halfe of that one sacke which he lent him: for a *Cylinder* or sacke having one foot of diameter, and 6 foot of length, is but the 4 part of another *Cylinder*, whose length is 6 foot, and his diameter is 2 foot: therefore two of the lesser *Cylinders* or sackes is but halfe of the greater; and so *Caius* was deceived in halfe his *Corne*.

3. *Incident.*

Some one from a common *Fountaine* of a *Citie* hath a *Pipe of water* of an inch diameter;

ter; to have it more commodious, he hath leave to take as much more *water*, whereupon hee gives order that a *Pipe* be made of two inches diameter. Now you will say presently that it is reason to bee so bigge, to have just twice as much *water* as he had before: but if the *Magistrate* of the *Citie* understood *Geometricall* proportions, hee would soone cause it to bee amended, and shew that hee hath not onely taken twice as much *water* as hee had before, but foure times asmuch; for a *Circular* hole which is two inches diameter is foure times greater than that of one inch; and therefore will cast out foure times asmuch *water* as that of one inch, and so the deceit is double also in this.

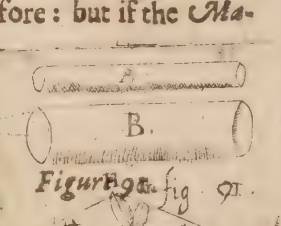


Figure 91. fig 91.

Moreover if there were a heape of *Corne* of 20 foot every way, which was borrowed to be paid next yeare: the party having his *Corne* in heapes of 12 foote every way, and of 10 foote every way, proffers him 4 heapes of the greater, or 7 heapes of the lesser, for his owne heape of 20 every way, which was lent: here it seemes that the proffer is faire, nay with advantage, yet the losse would be neare 1000 foot. Infinite of such causes doe arise from *Geometricall figures*, which are able to deceive a *Iudge* or *Magistrate*,

Magistrate, which is not somewhat seene in *Mathematicall Documents.*

PROBLEM. LXXXVIII.

Containing sundry Questions in matter of Cosmography.

First, it may be demanded, where is the middle of the *world*; I speake not here *Mathematically*, but as the vulgar people who aske where is the middle of the *world:* in this sence to speake absolutely there is no point which may be said to be the middle of the surface; for the middle of a *Globe* is every where: notwithstanding the *Holy Scriptures* speaketh respectively, and makes mention of the middle of the *earth*, and the interpreters apply it to the Citie of *Ierusalem* placed in the middle of *Palestina*, and the habitable *world*; that in effect taking a mappe of the *world*, and placing one foot of the *Compasses* upon *Ierusalem*, and extending the other foot to the extremity of *Europe*, *Asia*, and *Africa*; you shall see that the Citie of *Ierusalem* is as a Center to that *Circle.*

2. *Secondly, how much is the depth of the earth, the height of the heavens, and the compasse of the world.*

FFom the surface of the *earth* unto the Center according to ancient traditions, is 3436 miles,

miles, so the whole thickeneſſe is 6872 miles, of which the whole compaſſe or circuit of the *earth* is 21600 miles.

From the Center of the *earth* to the *Moone* there is neare 56 *Semidiameters* of the *earth*, which is about 192416 miles: unto the *Sunne* there is 1142 *Semidiameters* of the *earth*, that is in miles 3924912; from the *ſtarry firmament* to the Center of the *earth* there is 14000 *Semidiameters*, that is, 48184000 miles, according to the opinion and obſervation of that learned *Tycho Brahe*.

From theſe meaſures one may collect by *Arithmeticall* ſupputations, many pleaſant propoſitions in this manner.

Firſt, if you imagine there were a hole through the *earth*, and that a *milſtone* ſhould bee let fall downe into this hole, and to move a mile in each minute of time, it would be more than two dayes and a halfe before it would come to the Center, and being there it would hang in the *aire*.

Secondly, if a man ſhould goe every day 20 miles, it would bee three yeares wanting but a fortnight before he could goe once about the *earth*; and if a *Bird* ſhould fly round about it in two dayes, then muſt the motion be 450 miles in an houre.

Thirdly, the *Moone* runnes a greater compaſſe each houre, than if in the ſame time ſhee ſhould runne twice the *Circumference* of the whole *earth*.

Fourthly, admit it bee ſuppoſed that one ſhould

should goe 20 miles in ascending upwards the heavens every day, hee should bee above 15 yeares before hee could attaine to the *Orbe* of the *Moone*.

Fifthly, the *Sunne* makes a greater way in one day than the *Moone* doth in 20 dayes, because that the *Orbe* of the *Sunnes circumference* is at the least 20 times greater than the *Orbe* of the *Moone*.

Sixthly, if a *milstone* should descend from the place of the *Sunne* a thousand miles every houre, (which is above 15 miles in a minute, farre beyond the proportion of motion) it would be above 163 dayes before it would fall downe to the *earth*.

Seventhly, the *Sunne* in his proper spheare moves more than seven thousand five hundred and seventy miles in one minute of time: now there is no *Bullet* of a *Cannon*, *Arrow*, *Thunderbolt*, or tempest of winde that moves with such quickenesse.

Eighthly, it is of a farre higher nature to consider the exceeding and unmoveable quicknesse of the *starry firmament*, for a *starre* being in the *Equator*, (which is just betweene the *Poles* of the *world*) makes 12598666 miles in one houre, which is *two hundred, nine thousand nine hundred and ninety foure miles* in one minute of time: & if a *Horseman* should ride every day 40 miles, hee could not ride such a compasse in a thousand yeares as the *starry firmament* moves in one houre, which is more than if one should move about the *earth* a thousand times

times in one houre, and quicker than possible thought can be imagined: and if a *starre* should fly in the *aire* about the *earth* with such a prodigious quickenesse, it would burne and consume all the *world* here below. Behold therefore how time passeth and death hasteth on: this made *Copernicus*, not unadvisedly to attribute this motion of *Primum mobile* to the *earth*, and not to the *starry firmament*: for it is beyond humaine sence to apprehend or conceive the rapture and violence of that motion being quicker than thought; and the word of *God* testifieth that the *Lord* made all things in *number, measure, weight*, and *time*.

Problem. LXXXXII.

To finde the Bissextile yeare, the Dominicall letter, and the letters of the moneth.

Let 123, or 124, or 125, or 26, or 27, (which is the remainder of 1500, or 1600) be divided by 4, which is the number of the *Leape-yeare*, and that which remaines of the division shewes the *Leape yeare*; as if one remaine, it shewes that it is the first *yeare* since the *Bissextile* or *Leape yeare*: if two, it is the second *yeare*, &c. and if nothing remaine, then it is the *Bissextile* or *Leape yeare*, and the Quotient shewes you how many *Bissextiles* or *Leape yeares* there are contained in so many *yeares*.

To

To finde the Circle of the Sun by the fingers.

LEt 123, 24, 25, 26, or 27, bee divided by 28, (which is the *Circle* of the *Sunne*, or whole revolution of the *Dominicall letters*) and that which remaines is the number of *joynts*, which is to bee accounted upon the *fingers* by *Filius este Dei, cœlum bonus accipe gratis*: and where the number ends, that *finger* it sheweth the yeare which is present, and the words of the verse shewes the *Dominicall letter*.

Example.

DIvide 123 by 28 for the *yeare*, (and so of other *yeares*) and the Quotient is 4, and there remaineth 11, for which you must account 11 words; *Filius este Dei, &c.* upon the *joynts* beginning from the first *joynt* of the *Index*, and you shall have the answere.

For the present to know the *Dominicall letter* for each moneth, account from *Ianuary* unto the moneth required, including *Ianuary*; and if there bee 8, 9, 7, or 5, you must begin upon the end of the *finger* from the thumbe and account, *Adam degebat, &c.* as many words as there are moneths, for then one shall have the letter which begins the moneth; then to know what day of the moneth it is, see how many times 7 is comprehended in the number of dayes, and take the rest: suppose 4. account upon the first finger within and without by the *joynts* unto

unto the number of 4, which ends at the end of the *finger*: from whence it may bee inferred that the day required was *Wednesday*, *Sunday* being attributed to the first *joynt* of the first *finger* or *Index*: and so you have the present *yeare*, the *Dominicall letter*, the letter which begins the *Moneth*, and all the dayes of the *Moneth*.

PROBLEM. LXXXXIII.

To finde the New and Full Moone in each Moneth.

ADde to the *Epact* for the *yeare*, the *Moneth* from *March*; then subtract that surplus from 30, and the rest is the day of the *Moneth* that it will bee *New Moone*, and adding unto it 14, you shall have that *Full Moone*.

Note.

THat the *Epact* is made alwayes by adding 11 unto 30, and if it passe 30, subtract 30, and adde 11 to the remainder: and so *ad infinitum*: as if the *Epact* were 12, adde 11 to it makes 23 for the *Epact*, next yeare, to which adde 11 makes 34; subtract 30, rests 4: the *Epact* for the yeare after, and 15 for the yeare following that, and for the next, and 7 for the next, &c.

PROB-

PROBLEM. LXXXXIIII.

To finde the Latitude of a Countrey.

THese that dwell betweene the *North Pole* and the *Tropicke* of *Cancer*, have their *spring* and *summer* betweene the 10. of *March*, and the 13. of *September*: and therefore in any day betweene that time, get the sunnes distance by instrumentall observation from the zenith at noone, and adde the declination of the *sunne* for that day to it: so the Aggragate, or such is the *Latitude*, or *Poles* height of that *Countrey*. Now the *declination* of the *sunne* for any day is found out by *Tables* calculated to that end: or *Mechanically* by the *Globe*, or by *Instrument* it may be indifferently had: and here note that if the day be betweene the 13. of *September* and the 10. of *March*, then the *sunnes declination*, for that day must be taken out of the distance of the *sunne* from the *zenith* at noone: so shall you have the *Latitude*, as before.

PROBLEM. LXXXXV.

Of the Climats of countries, and to finde in what Climate any countrey is under.

CLimats as they are taken *Geographically* signifie nothing else but when the length

of the longeſt day of any place, is halfe an houre longer, or ſhorter than it is in another place (and ſo of the ſhorteſt day) and this account to begin from the *Equinoctiall Circle*, ſeeing all *Countries* under it have the ſhorteſt and longeſt day that can bee but 12. *houres*; But all other *Countries* that are from the *Equinoctiall Circle* either towards the *North* or *South* of it unto the *Poles* themſelves, are ſayd to bee in ſome one *Climate* or other, from the *Equinoctiall* to either of the *poles Circles*, (which are in the Latitude of 66. gr. 30. m.) betweene each of which *poler Circles* and the *Equinoctiall Circle* there is accounted 24 *Climats*, which differ one from another by halfe an *hours* time: then from each *Poler Circle*, to each *Pole* there are reckoned 6. other *Climats* which differ one from another by a months time: ſo the whole *earth* is divided into 60. *Climats*, 30 being allotted to the *Northerne Hemiſpheare*, and 30. to the *Southerne Hemiſpheare*. And here note that though theſe *Climats* which are betweene the *Equinoctiall* & the *poller Circles* are equall one unto the other in reſpect of time, to wit, by halfe an *houre*, yet the *Latitude*, *breadth*, or *internall*, contained betweene *Climate* and *Climite*, is not equall: & by how much any *Climate* is farther from the *Equinoctiall* than another *Climate*, by ſo much the leſſer is the internall betweene that *Climate* and the next: ſo theſe that are neareſt the *Equinoctial* are largeſt; and theſe w^ch are fartheſt off moſt contracted: & to find what *Climate* any *Countrey* is under:

ſubtract

subtract the length of an *Equinoctiall day* to wit, 12. *houres* from the length of the longest day of that *Countrey*; the remainder being doubled shewes the *Climate*: So at *London* the longest day is neare 16. *houres* and a halfe; 12. taken from it there remaines 4. *houres* and a halfe, which doubled makes 9. halfe *houres*, that is, 9. *Climats*; so *London* is in the 9. *Climate*.

Problem. LXXXXVI.

Of Longitude and Latitude of the Earth and of the Starres.

Longitude of a *Countrey*, or *place*, is an arcke of the *Æquator* contained betweene the *Meridian* of the *Azores*, and the *Meridian* of the place; and the greatest *Longitude* that can be is 360 degrees.

Note.

That the first *Meridian* may be taken at pleasure upon the *Terrestriall Globe* or *Mappe*, for that some of the ancient *Astronomers* would have it at *Hercules Pillars*, which is at the straights at *Gibralter*: *Ptolomy* placed it at the *Canary Ilands*, but now in these lattter times it is held to bee neare the *Azores*. But why it was first placed by *Ptolomy* at the *Canary Ilands*, was because that in his time these *Ilands* were the farthest westerne parts of the world that was then discovered: And why it retaines his place now at Saint *Michels* neare the

Azores, is that becauſe of many accurate obſervations made of late by many expert *Navigators* and *Mathematicians*, they have found the *Needle* there to have no *variation*, but to point *North* and *South*; that, is to each *Pole* of the world: and why the *Longitude* from thence is accounted *Eaſtwards*, is from the motion of the *Sunne Eaſtward*; or that *Ptolomy* and others did hould it more convenient to begin from the *weſterne* part of the world and ſo account the *Longitude Eaſtward* from *Countrey* to *Countrey* that was then knowne; till they came to the *Eaſterne* part of *Aſia*, rather than to make a beginning upon that which was unknowne: and having made up their account of reckoning the *Longitude* from the *Weſterne* part to the *Eaſterne* part of the world knowne, they ſuppoſed the reſt to be all ſea; which ſince their deaths hath beene found almoſt to be another habitable world.

To finde the Longitude of a Countrey.

IF it be upon the *Globe*, bring the *Countrey* to the *Braſen Meridian*, and whatſoever degree that *Meridian* cuts in the *Equinoctiall*, that degree is the *Longitude* of that *Place*: if it be in a *Mappe*, then marke what *Meridian* paſſeth over it; ſo have you the *Longitude* thereof: if no *Meridian* paſſe over it, then take a paire of *Compaſſes*, and meaſure the diſtance betweene the *Place* and the next *Meridian*, and apply it

to

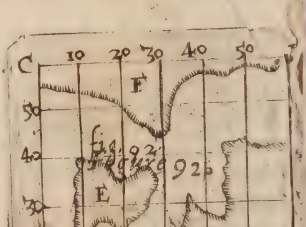
to the diuided parallel or *Æquator*; so have you the *Longitude* required.

Of the Latitude of Countries.

LAtitude of a *Countrey* is the distance of a *Countrey* from the *Equinoctiall*, or it is an Arke of the *Meridian* contained betweene the *Zenith* of the place and the *Æquator*; which is twofold, *viz.* either *North Latitude* or *South Latitude*, eyther of which extendeth from the *Equinoctiall* to eyther *Pole*; so the greateſt *Latitude* that can be is but 90. degrees: If any Northerne *Countrey* have the *Artick Circle* verticall, which is in the *Latitude* of 66.gr.30.m. the *ſunne* will touch the *Horizon* in the *North* part thereof, and the longeſt day will be there then 24. houres: if the *Countrey* have leſſe *Latitude* than 66. degrees 30.m. the ſunne will riſe and ſet; but if it have more *Latitude* than 66.gr.30.m. it will bee viſible for many *dayes*: and if the *Countrey* bee under the *Pole*, the *ſunne* will make a *Circular* motion above the *Earth* and be viſible for a halfe *yeare*: ſo under the *Pole* there will be but one *day*, and one *night* in the whole *yeare*.

To

To finde the Latitude of Countries.



IF it be upon a *Globe*, bring the place to the *Brasen Meridian*, and the number of degrees which it meeteth therewith, is the *Latitude* of the place. Or with a paire of *Compasses* take the distance betweene the *Countrey* and the *Equinoctiall*; which applyed unto the *Equinoctiall* will shew the *Latitude* of that *Countrey*; which is equall to the *Poles* height; if it be upon a *Mappe*. Then marke what parallel passeth over the *Countrey* and where it crosseth the *Meridian*, that shall be the *Latitude*: but if no parallel passeth over it, then take the distance betweene the place and the next parallell, which applyed to the divided *Meridian* from that parallell will shew the *Latitude* of that place.

To finde the distance of Places.

IF it be upon a *Globe*: then with a paire of *Compasses* take the distance betweene the two places, and apply it to the divided *Meridian* or *Æquator*, and the number of degrees shall shew the distance; each degree beeing 60. miles,

miles. If it be in a *Mappe (according to Wrights projection)* take the distance with a paire of *Compasses* betweene the two places, and apply this distance to the divided *Meridian* on the *Mappe* right against the two places; so as many degrees as is contained betweene the feete of the *Compasses*, so much is the distance betweene the two places. If the distance of two places be required in a particular *Mappe* then with the *Compasses* take the distance betweene the two places, and apply it to the scale of *Miles*, so have you the distance: if the scale bee too short, take the scale betweene the *Compasses*, and apply that to the two *Places* as often as you can, so have you the distance required.

Of the Longitude, Latitude, Declination, and distance of the Starres.

THe *Declination* of a *starre* is the neareſt distance of a *starre* from the *Æquator*; the *Latitude* of a *starre* is the neareſt distance of a starre from the *Ecliptick*: the *Longitude* of a *starre* is an Arke of the *Ecliptick* contained betweene the beginning of *Aries*, and the Circle of the *starres Latitude*, which is a *Circle* drawne from the *Pole* of the *Ecliptick* unto the *starre*, and so to the *Ecliptick*. The distance betweene two *starres* in heaven is taken by a *Croſſe ſtaffe* or other *Inſtrument*, and upon a *Globe* it is done by taking betweene the feet of the *Compasses* the two *starres*, and applying it

to the *Æquator*, so have you the distance betweene those two *starres*.

How it is that two Horses or other creatures being foled or brought forth into the world at one and the same time, that after certaine dayes travell the one lived longer than the other, notwithstanding they dyed together in one and the same moment also.

THis is easie to be answered: let one of them travell towarde the West and the other towards the East: then that which goes towards the West followeth the Sunne: shall have the day somewhat longer than if there had beene no travell made: and that which goes East by going against the Sunne, shall have the day shorter: and so respect of travell though they dye at one and the selfe same houre and moment of time, the one shall be older than the other.

From which consideration may be inferred that a Christian, a Iew, and a Zarazen, may have their Sabbaths all upon one and the same day, though notwithstanding the Zarazen houlds his Sabath upon the Friday, the Iew upon the Saturday, and the Christian upon the Sonday: For being all three resident in one place, if the Zarazen and the Christian begin their travell upon the Saturday, the Christian going West: and the Zarazen Eastwards, shall compasse the

a Globe

Globe of the earth, the Christian at the conclusion shall gaine a day and the Zarazen shall lose a day, and so meete with the Iew every one upon his owne Sabbath.

Certaine fine Observations.

VNder the *Equinoctiall* the *Needle* hangs in æquilibrio, but in these parts it inclines under the *Horizon*, and being under the *Pole* it is thought it will hang *verticall*. 1

In these *Countries* which are without the *Tropicall Circles*, the *Sunne* comes *East* and *West* every day for a halfe yeare; but being under the *Equinoctiall* the *Sunne* is never *East*, nor *West* but twice in the *yeare*, to wit, the 10. of *March* and the 13. of *September*. 2

If a *shippe* be in the *Latitude* of 23. gr. 30. m. that is, if it have eyther of the *Tropickes verticall*: then at what time the *Sunnes Altitude* is equall to his distance from any of the *Equinoctiall points*, then the *Sunne* is due *East* or *West*. 3

If a *shippe* be betweene the *Equinoctiall* and eyther of the *Tropicks*, the *Sunne* will come twice to one point of the *Compasse* in the forenoone, that is, in one and the same position. 4

VNder the *Equinoctiall* neare *Guinea* there is but two sorts of *winds* all the *yeare*, 6. months a *Northerly winde*, and 6. months a *Southerly winde*, and the flux of the *Sea* is accordingly. 5

If two *ships* under the *Equinoctiall* be 100. *leagues* asunder, and should sayle *Northerly* untill

untill they were come under the *Articke Circle*, they should then be but 50. *leagues* asunder.

7 These which have the *Articke Circle* verticall: when the *Sunne* is in the *Tropicke* of *Cancer*: the Sunne setteth not but toucheth the westerne part of the *Horizon*.

8 If the complement of the *Sunnes* height at noone be found equall to the Suns *Declination* for that day, then the *Equinoctiall* is verticall: or a *Shippe* making such an observation, the *Equinoctiall* is in the *Zenith* or direct over them: by which *Navigators* know when they crosse the line, in their travels to the *Indies*, or other parts.

9 The *Sunne* being in the *Equinoctiall*, the extremity of the still in any *Sunne dyall* upon a plaine; maketh a right line, otherwise it is *Ecliptical*, *Hyperbolicall*, *&c.*

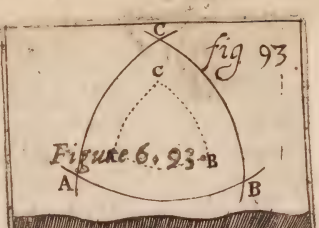
0 When the *shadow* of a man, or other thing upon a *Horizontall* plaine is equall unto it in length, then is the *Sunne* in the middle point betweene the *Horizon* and the *Zenith*, that is, 45. degrees high.

PROBLEME LXXXXVII.

To make a Triangle that shall have three right Angles.

OPen the *Compasses* at pleasure: and upon *A*, describe an Arke *B C*. then at the same opening, place one of the feet in *B*, and describe

scribe the Arke *A C*. Lastly, place one of the feet of the *Compasses* in *C*. and describe the Arke *A B*. so shall you have the *spherical Æquilaterall Triangle A B C*, right angled at *A*, at *B*, and at *C*. that is, each angle comprehended 90. degrees:



which can never be in any plaine *Triangle*, whether it be *Equilaterall*, *Isocelle*, *scaleve*, *Orthogonall*, or *Opigonall*.

Problem. LXXXXVIII.

To divide a line in as many equall parts as one will, without compasses, or without seeing of it.

This *Proposition* hath a fallacie in it, and cannot be practised but upon a *Maincordion*: for the *Mathematicall* line which proceedes from the flux of a point, cannot be divided in that wise: One may have therefore an *Instrument* which is called *Maincordion*, because there is but one cord: and if you desire to divide your line into 3. parts, run your finger upon the frets untill you found a third in musicke: if you would have the fourth part of the line, then

then finde the fourth ſound, a fift, &c. ſo ſhall you have the anſwer.

PROBLEM. LXXXXVIIII.

To draw a line which ſhall incline to another line, yet never meete: againſt the Axiome of Parallels.

THis is done by helpe of a *Conoyde line*, produced by a right line upon one and the ſame plaine, held in great account amongſt the Ancients, and it is drawne after this manner.

Draw a right line infinitely, and upon ſome end of it, as at *I*, draw a perpendicular line *I A*. augment it to *H*. then frō *A*. draw lines at pleaſure to interſect the line *I. M*. in each of which lines from the right line, *I. M*. transferre *I H*. viz. *K B. L C. O D. P E. Q F. M G*. then from thoſe points draw the line *H. B. C. D. E. F. G*. which will not meet with the line *I M*. and yet incline nearer and nearer unto it.

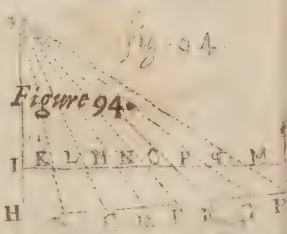


Figure 94.

PROB-

PROBLEM. C.

To observe the variation of the compasses, or needle in any places.

FIrst describe a *Circle* upon a plaine, so that the *Sunne* may shine on it both before noone and afternoone: in the center of which *Circle* place a *Gnomon* or *wire* prependicular as *A B.* and an houre before noone marke the extremitie of the shaddow of *A B.* which suppose it be at *C.* describe a *Circle* at that semidiameter *C D F.* then after noone marke when the top of the *shadow* of *A B.* toucheth the *Circle*, which admit in *D*; devide the distance *C D*, into two equall parts which suppose at *E.* draw the line *E A F.* which is the *Meridian* line, or line of *North* & *South*: now if the Arke of the *Circle C D.* bee devided into degrees: place a *Needle G H*, upon a plaine set up in the *Center*, & marke how many degrees the point of the *Needle G*, is from *E.* so much doth the *Needle* vary from the *North* in that place.

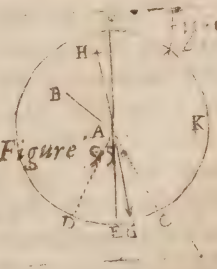


Figure 95.

PROB.

Problem. CI.

How to finde at any time which way the wind is in ones Chamber, without going abroad.

VVon the *Planching* or *floore* of a *Chamber*, *Parlor*, or *Hall*, that you intend to have this deviſe, let there come downe from the top of the *houſe* a hollow poſt, in which place an *Iron rod* that it aſcend above the *houſe* 10, or 6. *foote* with a *vane* or a *ſcouchen* at it to ſhew the *winds* without: and at the lower end of this rod of *Iron*, place a *Dart* which may by the mooving of the *vane* with the *winde* without, turne this *Dart* which is within: about which upon the plaiſter muſt be deſcribed a *Circle* divided into the 32. points of the *Mariners Compaſſe* pointed and diſtinguiſhed to that end: then may it be marked by placing a *Compaſſe* by it; for having noted the *North point*, the *Eaſt*, *&c.* it is eaſie to note all the reſt of the points: and ſo at any time comming into this *Roome*, you have nothing to doe but to looke up to the *Dart*, which will point you out what way the *winde* bloweth at that inſtant.

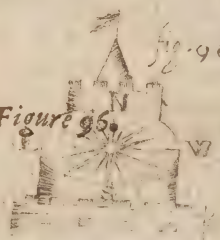


Figure 96.

Pro-

ward untill you may see the top of the *Tower* or *Tree*, which suppose at *E*. So the distance from your standing to the *Tower* or *Tree*, is equall to the height thereof above the levell of the *eye*: to which if you adde your owne *height* you have the whole *height*.

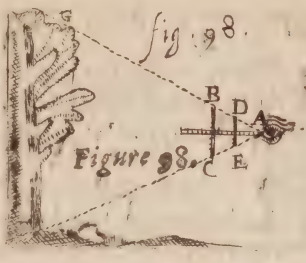


Figure 98.

Otherwise.

TAke an ordinary square w^th *Carpenders* or other workemen use, as *H K L.* and placing *H.* to the *eye* so that *H K.* be levell, goe backe or come nearer untill that by it you may see the top *M.* for then the distance from you to the *height* is equall to the *height*.

Figure 97.

PROBLEM. CV.

How to make ſtatues, letters, bowles, or other things which are placed in the ſide of a high building, to be ſeene below of an equall bigneſſe.

LEt *B C.* be a *Pillar* 27. *yards* high, and let it be required that three *yards* above the levell of the *eye A*, viz. at *B.* bee placed a *Globe* and 9 *yards* above *B.* be placed another, and 22. *yards* above that be placed another *Globe*: how much ſhall the *Diamiter* of theſe *Globes* be, that at the *eye*, at *A*, they may all appeare to be of one and the ſame *Magnitude*: It is thus done, firſt draw a line as *A K.* & upon *K.* erect a prependicular *K X.* divide this line into 27. parts, and according to *A K.* deſcribe an Arke *K Y.* then from *K.* in the perpendicular *K X*, account 3. parts. viz. at *L*, which ſhall repreſent the former three yardes, and draw the line *L A*: from *L*, in the ſayd perpendicular reckon the *diamiter* of the leſſer *Globe* of what *Magnitude* it is intended to be: ſuppoſe *S L.* and draw the line *S A.* cutting the Arke *V K.* in *N.* then from *K.* in the perpendicular account 9. *yards*, which admit at *T.* draw *T A.* cutting *Y K.* in *O.* transferre the Arke *M N.* from

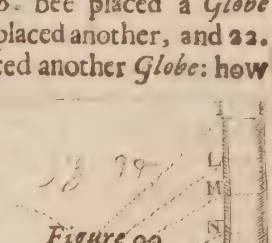


Figure 99.

A

A to *P*. and draw *A P*. which will cut the perpendicular in *V*. so a line drawne from the middle of *V F*. unto the visuall lines *A T*, and *A V*, shall be the diamiter of the next *Globe*: Lastly, account from *K*. in the perpendicular *X K*. 22 parts, and draw the line *W A*. cutting *Y K*, in *Q*. then take the Arke *M N*, and transferre it from *Q*, to *R*. and draw *A R*. which will cut the perpendicular in *X*. so the line which passeth by the middle of *X W*. perpendicular to the visuall line *A W*, and *A X*. be the *Diamiter* of the third *Globe*, to wit 5, 6. which measures transferred in the Pillar *B C*. which sheweth the true *Magnitude of the Globes* 1, 2, 3. from this an Architecter doth proportion his *Images*, and the foulding of the *Robes* which are most deformed at the *eye* below in the making, yet most perfect when it is set in his true height above the *eye*.

PROBLEM. CVI.

How to disguise or disfigure an Image, as a head, an arme, a whole body, &c. so that it hath no proportion, the eares to become long: the nose as that of a swan, the mouth as a coaches entrance, &c. yet the eye placed at a certaine point will be seene in a direct and exact proportion.

I Will not strive to set a *Geometricall* figure here for feare it may seeme too difficult to understand,

derstand, but I will indeavour by discourse how *Mechanically* with a *Candle* you may perceive it sencible: first there must be made a figure upon *Paper* such as you please, according to his just proportion, and paint it as a *Picture* (which painters know well enough to doe) afterwards put a *Candle* upon the *Table*, and interpose this figure obliquely, betweene the said *Candle* and the *Bookes* of *Paper*, where you desire to have the figure disguised in such sort that the height passe athwart the hole of the *Picture*: then will it carry all the forme of the *Picture* upon the *Paper*, but with deformity; follow these tracts and marke out the light with a *Coles blacke head* or *Inke*: and you have your desire.

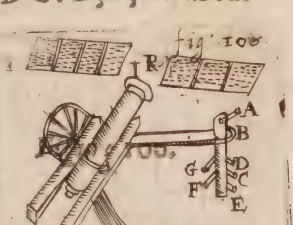
To finde now the point where the *eye* must see it in his naturall forme: it is accustomed according to the order of *Perspective*, to place this point in the line drawne in height, equall to the largenesse of the narrowest side of the deformed square, and it is by this way that it is performed.

Problem. CVII.

How a Canon after that it hath, shot may be covered from the battery of the enemy.

Let the mouth of a *Canon* be *I.* the *Canon M.* his charge *N O.* the *wheele L.* the *axletree P B.* upon which the *Canon* is placed, at which

which end towards *B*, is placed a pillar *A E*. supported with props *D C*. *E*, *F*, *G*. about which the *Axeltree* turneth: now the *Cannon* being to shoot it retires to *H*. which cannot be directly because of the *Axeltree*, but it make a segment of *Circle*, & hides himselfe behind the *wall Q R*, and so preserves it selfe from the *Enimies battery*, by which meanes one may avoyd many inconveniences which might arise : and moreover one man may more easily replace it againe for another shot by helpe of polies tyed to the wall, or other helpes which may multiply the strength.



PROBLEM. CVIII.

How to make a Lever by which one man may alone place a Cannon upon his carriage, or raise what other weight he would.

First place two thicke boards upright, as the figure sheweth, pierced with holes, alike opposite one unto another as *C D*, and *E F*: and let *L*, and *M*, be the two barrs of *Iron* which passeth through the holes *G H*, and *F*, *K*; the

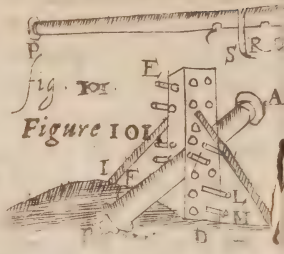


Figure 101.

two ſupports, or props, *A B*. the *Cannon*, *O P*, the *Lever R S*, the two notches in the *Lever*, and *Q*, the hooke where the burthen or *Cannon* is tyed to. The reſt of the operation is facill, that the youngeſt ſchollers or learners cannot faile to performe it: to teach *Minerva* were in vaine, and it were to *Mathematicians* injury in the ſucceeding Ages.

PROBLEM. CIX.

How to make a Clocke with one onely wheele.

Figure 102.

MAke the body of an ordinary *Dyall*, and divide the houre in the *Circle* into 12. parts: make a great wheele in height above the *Axeltree*, to the which you ſhall place the cord of your counterpoiſe, ſo that it may deſcend, that in 12

houres

houres of time your *Index* or *Needle* may make one revolution, which may bee knowne by a watch which you may have by you: then put a *balence* which may ſtop the courſe of the *wheele*, and give it a regular motion, and you ſhall ſee an effect as juſt from this as from a *Clocke* with many wheeles.

PROBLEM. CX.

How by helpe of two wheeles to make a Child to draw up alone a hogshead of water at a time: and being drawne up ſhall caſt out it ſelfe into another veſſell as one would have it.

LEt *R* be the *Pit* from whence *water* is to be drawne; *P*, the *hooke* to throw out the *water* when it is brought up (this *hooke* muſt be moveable) let *A B*, bee the *Axis* of the *wheele S F*, which *wheele* hath divers *forkes of Iron* made at *G*, equally faſtened at the *wheele*; let *I*, be a *Card*, which is drawne by *K*, to make the *wheele S*, to turne, which *wheele S*, beares proportion to the *wheele T*, as 8 to 2: let *N* be a *Chaine of Iron* to which is tyed the *veſſell O*: and the other which is in the *Pit*: *E F* is a peece of *wood* which hath a mortes in 1, and 2, by which the *Cord I*, paſſeth, tyed at the *wall*, as *K H*, and the other peece of *Timber* of the little *wheele* as *M*, mortiſed in likewiſe for the

chaine to passe through: draw the *Cord I*, by *K*, and the *wheele* will turne, and so consequently the *wheele T*, which will cause the *vessell O*, to raise: which being empty, draw the *Cord* againe by *Y*, and the other *vessell* which is in the pit will come out by the same reason. This is an invention which wil save labour if practised; but here is to be noted that the pit must be large enough, to the end that it containe two great *vessels* to passe up and downe one by another.

Figure 103.

Problem. CXI.

To make a Ladder of Cords which may be carryed in ones pocket: by which one may easily mount up a Wall, or Tree alone.

TAke two *Pullies A*, and *D*, unto that of *A*, let there be fastned a *Crampe of Iron* as *B*; and at *D*, let there be fastned a *staffe* of a *foote* & a halfe long as *F*, then the *Pully A*: place a hand of Iron, as *E*, to which tie a Cord of an halfe inch thicke (which may be of silke because it is for the pocket:) then strive to make fast the

Pully

Pully A, by the helpe of the *Crampe of Iron B*, to the place that you intend to scale; and the *staffe F*; being tyed at the *Pully D*, put it betweene your *legges* as though you would sit upon it: then houlding the *Cord C*, in your hand, you may guide your selfe to the place required: which may be made more facill by the multiplying of *Pullies*. This secret is most excellent in *Warre*, and for lovers, its supportableneſſe avoyds suspition.

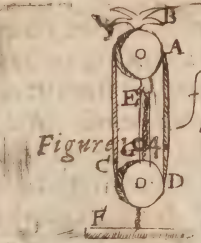


fig. 15
Figure

Problem. CXII.

How to make a Pumpe whose strength is marueilous by reason of the great weight of water that it is able to bring up at once, and so by continuance.

LEt $\alpha\beta\gamma\delta$, be the height of the *Case* about two or three *foote* high, and broader according to discretion: the rest of the *Case* or concavity let be *O*: let the sucker of the *Pumpe* which is made, be just for the *Case* or *Pumpes* head $\alpha\beta\gamma\delta$, & may be made of wood or *brasse* of 4. inches thick, having a hole at *E*, which descending

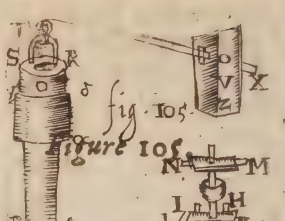


Figure 105

scending raiseth up the cover *P*, by which issueth forth the water and ascending or raising up it shuts it or makes it close: *R S*, is the handle of the sucker tyed to the handle *T X*, which works in the post *V Z*. Let *A,B,C,D*, be a peece of *Brasse*, *G* the peece which enters into the hole to *F*, to keepe out the *Ayre*. *H,I,K,L*, the peece tyed at the funnell or *pipe*: in which playes the *Iron* rod or *axis G*, so that it passe through the other peece *M N*, which is tyed with the end of the pipe of *Brasse*.

Note, that the lower end of the *Cisterne* ought to bee rested upon a *Grediron* or *Iron Grate*, which may be tyed in the pit; by which meane lifting up and putting downe the handle, you may draw ten times more *water* than otherwise you could.

Problem. CXIII.

How by meanes of a Cisterne, to make water of a Pit continually to ascend without strength, or the assistance of any other Pumpe.

LEt *I L*, be the Pit where one would cause *water* to ascend continually to each office of

of a *houſe* or the places which are ſeparated from it: let there be made a *receiver* as *A*, well cloſed up with *lead* or other matter that *ayre* enter not in, to which faſten a *pipe* of *lead* as at *E*, which may have vent at pleaſure: then let there bee made a *Ciſterne* as *B*, which may bee communicative to *A*, by helpe of the pipe *G*, from which *Ciſterne B*, may iſſue the water of *pipe D*, which may deſcend to *H*, which is a little below the levell of the *water* of the *pit* as much as is *G H*: to the end of which ſhall be ſoudred cloſe a *Cocke* which ſhall caſt out the water by *KH*. Now to make uſe of it, let *B* be filled ful of water, & whē you would have it run turne the *Cocke*, for then the water in *B*, will deſcend by *K*: and for feare that there ſhould be vacuity, nature which abhors it, will labour to furniſh and ſupply that emptineſſe out of the ſpring *F*, and that the *Pit* dry not, the *Pipe* ought to bee ſmall of an indifferent capacitie according to the greatneſſe or ſmalneſſe of the ſpring.

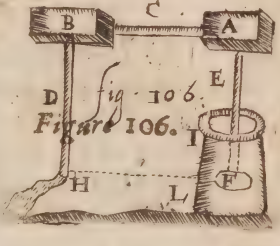


Figure 106.

PROB.

PROBLEM. CXIIII.

How out of a fountaine to cast the water very high: different from a Probleme formerly delivered.

LEt the *fountaine* be *B D*, of a round forme (seeing it is the most capable and most perfects figure) place into it two *pipes* conjoyned as *E A*, and *H C*, so that no *Ayre* may enter in at the place of joyning: let each of the *Pipes* have a *Cocke G*, and *L*: the *Cocke* at *G*, being closed, open that at *I*, and so with a squirt force the *water* through the hole at *H*, then close the *Cocke* at *A*, and draw out the *squirt*, and open the *Cocke* at *G*: the *Aire* being before rarified will extend his dimensions and force the *water* with such violence, that it will amount above the height of one or two *Pikes*: and so much the more by how much the *Machine* is great: this violence will last but a little while if the Pipe have too great an opening, for as the *Ayre* approacheth to his naturall place, so the force will diminish.

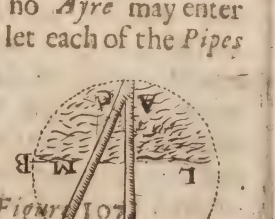


Figure 107

PROB-

PROBLEME CXV.

How to empty the water of a Cisterne by a Pipe which shall have a motion of it selfe.

LEt *A B*, be the *vessell*; *C D E*, the *Pipe*: *H G*, a little *vessell* under the greater, in which one end of the *Pipe* is, viz. *C*, and let the other end of the *Pipe E*, passe through the bottome of the *vessell* at *F*, then as the *vessell* filleth so will the Pipe, & when the *vessell* shall be full as farre as *P O*, the *Pipe* will begin to runne at *E*, of his owne accord, and never cease untill the *vessell* bee wholly empty.

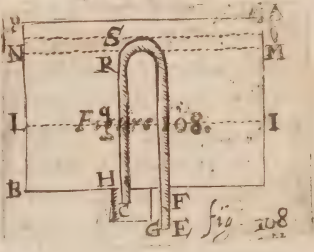


Figure 108. *fig.* 108

PROBLEM. CXVI.

How to squirt or spout out a great height, so that one pot of water shall last a long time.

LEt there be prepared two *vessels* of *Brasse*, *lead*, or of other matter of equall substance, as are the two *vessels A B*, and *B D*, & let them be joyned together by the two Pillars *M N*, and *E F*: then let there be a pipe *H G*. which may passe through the cover of the *vessell C D*, and passe through *A B*, into *G*, making a little bunch or rising in the cover of the *vessell A B*, so that the pipe touch it not at the bottome: then

then let there be sodered fast another *Pipe I L*, which may be separated from the bottome of the *vessell*, and may have his bunchie swelling as the former without touching the bottome: as is represented in *L*, and passing through the bottome of *A B*, may be continued unto *I*, that is to say, to make an opening to the cover of the vessell *A B*, & let it have a little mouth as a *Trumpet:* to that end to receive the *water*. Then there must further be added a very small *Pipe* which may passe through the bottome of the *vessell A B*, as let it be *O P*, and let there be a bunch, or swelling over it as at *P*, so that it touch not also the bottome: let there be further made to this lesser *vessell* an edge in forme of a *Basen* to receive the water, which being done powre *water* into the *Pipe I L*, untill the *vessell C D*, be full: then turne the whole *machine* upside downe that the *vessell C D*, may be uppermost, and *A B*, undermost: so by helpe of the *Pipe G H*, the *water* of the *vessell C D*, will runne into the *vessell A B*, to have passage by the *Pipe P O*. This motion is pleasant at a feast in filling the said *vessell* with wine, which will spout it out as though it were from a *boyling fountaine*, in the forme of a thred very pleasant to behould.

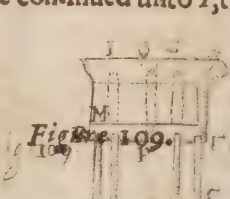


Figure 109.

PROB-

Problem. CXVII.

How to practise excellently the reanimation of simples, in case the plants may not be transported to be replanted by reason of distance of places.

TAke what simple you please, burne it and take the ashes of it, and let it bee calcinated two *houres* betweene two *Creusets* well luted, and extract the salt: that is, to put *water* into it in moving of it; then let it settle, and doe it two or three times, afterwards evaporate it, that is, let the *water* be boyled in some *vessell*, untill it bee all consumed: then there will remaine a salt at the bottome, which you shall afterwards sowe in good *Ground* well prepared: such as the Theater of husbandry sheweth, and you shall have your desire.

Problem. CXVIII.

How to make an infalliable perpetuall motion.

MIxe 5. or 6. ounces of ☿ with his equall weight of ♄, grinde it together with 10. or 12. ounces of sublimate dissolved in a celler upon a *Marble* the space of 4. dayes, and it will become like *Oyle Olive*, which destill with fire of chaffe or driving fire, and it will sublime

sublime dry substance, then put water upon the earth (in forme of Lye) which will be at the bottome of the Limbecke and dissolve that which you can filter it, then distill it, and there will bee produced very subtill Atomes, which put into a bottle close stopped, and keepe it dry, and you shall have your desire, with astonishment to all the world, and especially to these which have travelled herein without fruit.

PROBLEM. CXIX.

Of the admirable invention of making the Philosophers Tree, which one may see with his eye to grow by little and little.

TAke two ounces of *Aqua fortis* and dissolve in it halfe an ounce of fine *silver* refined in a *Cappell*: then take an ounce of *Aqua fortis* and two drams of *Quicke silver*: which put in it, and mixe these two dissolved things together; then cast it into a Viole of halfe a pound of *water*, which may be well stopped; for then every day you may see it grow both in the Tree and in the branch. This liquid serves to blacke haire which is *red*, or *white*, without fading untill they fall: but here is to be noted that great care ought to bee had in annointing the haire, for feare of touching the *flesh*: for this composition is very *Corrosive*, or searching that as soone as it toucheth the *flesh* it raiseth blisters, and bladders very painefull.

PROB-

PROBLEM. CXX.

How to make the representation of the great world.

DRaw *salt niter* out of salt *Earth* which is found along the *Rivers* side, and at the foote of *Mountaines*, where especially are *Minerals* of *Gould* and *silver*: mixe that *Niter* well clensed with ☿, then calcinate it hermetically; then put it in a *Limbecke* and let the receiver be of *Glasse*, well luted, and alwayes in which let there be placed leaves of *Gould* at the bottome, then put *fire* under the *Limbecke* untill vapours arise which will cleve unto the *Gould*; augment your *fire* untill there ascend no more, then take away your receiver and close it hermetically, & make a *Lampe fire* under it untill you may see presented in it that which nature affords us: as *Flowers, Trees, Fruits, Fountaines, Sunne, Moone, Starres, &c.* Behould here the forme of the *Limbecke*, and the receiver: *A* represents the *Limbecke*, *B* stands for the receiver.

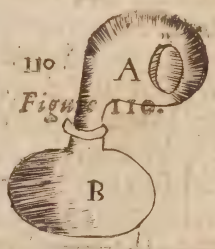
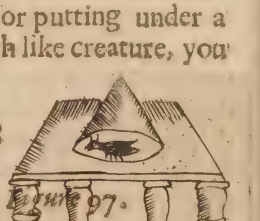


Figure 110.

Problem CXXI.

How to make a Cone, or a Pyramidall body move upon a Table without springs or other Artificiall meanes: so that it shall move by the edge of the Table without falling.

THis proposition is not so thornie and subtile as it seemes to be, for putting under a *Cone of paper a Beetle* or such like creature, you shall have pleasure with astonishment & admiration to these which are ignorant in the cause: for this *animall* will strive alwayes to free herselfe from the captivity in which shee is in by the imprisonment of the *Cone*: for comming neere the edge of the *Table* shee will returne to the other side for feare of falling.



Problem. CXXII.

To cleave an Anvill with the blow of a Pistoll.

THis is proper to a *warrier*, and to performe it, let the *Anvill* be heated red hot as one can

can possible, in such sort that all the solidity of the body bee softned by the *fire*: then charge the *Pistoll* with a bullet of *silver*, and so have you infallibly the experiment.

Problem. CXXIII.

How to roast a Capon carried in a Budget at a Saddle bow, in the space of riding 5. or 6. miles.

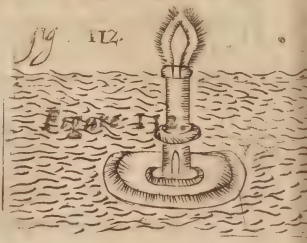
HAving made it ready and larded it, stuffe it with *Butter*; then heate a peece of *steele* which may be formed round according to the length of the *Capon*, and big enough to fill the *Belly* of it, and then stop it with *Butter*; then wrap it up well and inclose it in a *Box* in the *Budget*, and you shall have your desire: it is said that *Count Mansfield* served himselfe with no others, but such as were made ready in this kind, for that it loseth none of its substance, and it is dressed very equally.

Problem. CXXIIII.

How to make a Candle burne and continue three times as long as otherwise it would.

VNto the end of a *Candle* halfe burned sticke a *farthing* lesse or more, to make it hang

perpendicular in a *veſſell of water*, ſo that it ſwimme above the *water*; then light it, and it will ſuſtaine it ſelfe & floate in this manner; and being placed into a *fountaine*, *pond*, or *lake* that runs ſlowly, where many people aſſemble, it will cauſe an extreame feare to theſe which come therein in the night, knowing not what it is.



PROBLEM. CXXV.

How out of a quantitie of wine to extract that which is moſt windy, and evill, that it hurt not a ſicke Perſon.

TAke two *viols* in ſuch ſort that they bee of like greatneſſe both in the belly and the necke; fill one of them of *wine*, and the other of *water*: let the mouth of that which hath the *water* be placed into the mouth of that which hath the *wine*, ſo the *water* ſhall

be

be uppermoſt: now becauſe the *water* is heavier than the *wine*, it will deſcend into the other *viall*, and the wine which is higheſt will aſcend above to ſupply the place of the *water*, and ſo there will be a mutuall interchange of liquids: and by this penitration the wine will loſe her vapors.

PROBLEM. CXXVI.

How to make two Marmouzets one of which ſhall light a Candle, and the other put it out.

VVon the ſide of a wall make the figure of a *Marmouzet* or other animall or forme, and right againſt it on the other *wall* make another; in the mouth of each put a pipe or quill ſo *artificially* that it be not perceived: in one of which place *ſalt peeter* very fine, and dry and pulueriſed: and at the end ſet a little match of *Paper*: in the other place *ſulphur* beaten ſmall: then houlding a *Candle* lighted in your hand, ſay to one of theſe *Images* by way of commaund, blow out the *Candle*: then lighting the *Paper* with the *Candle*, the *ſalt peeter* will blow out the *Candle* immediatly: and going to the other *Image* (before the match of the *Candle* be out) touch the ſulphur with it and ſay, light the *Candle*, and it will immediatly be lighted, which will cauſe an admiration to theſe which ſee the action: if it be done with a ſecret dexterity.

Problem. CXXVII.

How to keepe wine fresh as if it were in a celler, though it were in the heate of Summer, and without Ice or snow, yea though it were carried at a saddles bow, and exposed to the Sunne all the day.

SEt your *wine* in a violl of *Glasse*; and place it in a *Box* made of *wood, leather*, or such like: about which *violl* place *salt peeter*, and it will preserve it and keepe it very fresh: this experiment is not a little commodious for these which are not neare *fresh waters*, and whose dwellings are much exposed to the Sunne.

Problem. CXXVIII.

To make a Cement which indureth or lasteth as marble, which resisteth ayre and water without ever disjoyning or uncemiting.

TAke a quantitie of strong and gluing *Morter* well beaten, mixe with this as much new *sleaked Lime*, and upon it cast *Oyle* of *Olive*, or *Linseede Oyle*, and it will become hard as *Marble* being applyed in time.

Prob.

PROBLEM. CXXIX.

How to melt mettle very quicke, yea in a shell upon little fire.

MAke a bed upon a bed of mettle with powder of Sulphur, of *Salt peeter*, and *sawdust* alike; then put fire to the sayd powder with a burning Charcole, and you shall see that the mettle will dissolve incontinent and bee in a Masse. This secret is most excellent and hath beene practised by the reverend father *Mercenne* of the order of the *Minims*.

PROBLEM. CXXX.

How to make Iron or Steele exceeding hard.

QVench your *Blade* or other *Instrument* seven times in the blood of a *male Hog*, mixt with *Goose grease*, and at each time dry it at the *fire* before you wet it: and it will become exceeding hard, and not brittle, which is not ordinary according to other temperings and quenchings of *Iron*: an experiment of small cost, often proved, and of great consequence for *Armorie* in warlike negotiations.

PRO-

PROBLEM. CXXXI.

To preserve fire as long as you will, imitating the inextinguable fire of Vestales.

AFter that you have extracted the burning spirit of the salt of ♄, by the degrees of *fire*, as is required according to the Art of *Chimistrie*, the fire being kindled of it selfe, breake the *Limbecke*, and the *Irons* which are found at the bottome will flame and appeare as burning *Coles* as soone as they feele the ayre; wch if you promtly inclose in a violl of *Glasse*, and that you stop it exactly with some good *lute*: or to be more assured it may be closed up with Hermes *wax* for feare that the Ayre get not in. Then will it keepe more than a thousand *yeares* (as a man may say) yea at the bottome of the *Sea*; and opening it at the end of the time, as soone as it feeles the Ayre it takes fire with which you may light a *Match*. This secret merits to be travailed ofter and put in practise, for that it is not common, and full of astonishment, seeing that all kind of *fire* lasteth but as long as his *matter* lasteth, and that there is no *matter* to be found that will so long indure.

FINIS.

Artificiall fire-Workes:

Or the manner of making of *Rockets* and *Balls* of fire, as well for the *Water*, as for the *Ayre*; with the composition of *Stars*, *Golden-raine*, *Serpents*, *Lances*, *Wheeles of fire*, and such like, pleasant and *Recreative*.

Of the composition for Rockets.

IN the making of *Rockets*, the cheefest thing to be regarded is the composition that they ought to be filled with, for as much as that which is proper to *Rockets* which are of a lesse sort is very improper to those which are of a more greater forme; for the fire being lighted in a great concave, which is filled with a quick composition, burnes with great violence; contrarily, a weake conposition being placed into a small concave, makes no effect: therefore we shall here deliver in the first place rules and directions, which may serve for the true composition, or matter with which you may charge any *Rocket*, from *Rockets* which are charged but with one ounce of

Powder unto great *Rockets* which requireth for their charge 10. pound of *Powder*, as followeth

For Rockets of one ounce.

Vnto each pound of good musket *Powder* small beaten, put two ounces of small *Cole duſt*, and with this compoſition charge the *Rocket.*

For Rockets of 2, or 3. ounces.

Vnto every foure ounces and a halfe of powder duſt, adde an ounce of *Salt-peeter*, or to every 4. ounces of *powder duſt*, adde an ounce of *Coleduſt*.

For Rockets of 4. ounces.

Vnto every pound of *Powder duſt* adde 4. ounces of *Salt peeter* & one ounce of *Coleduſt*: but to have it more ſlow, unto every 10. ounces of good *duſt powder* adde 3. ounces of *Salt-peeter*, and 3. ounces of *Coleduſt.*

For Rockets of 5. or 6. ounces.

Vnto every pound of *Powder duſt*, adde 3. ounces and a halfe of *Salt peeter*, and 2. ounces and a halfe of *Cole duſt*, as alſo an ounce of *Sulpher* and an ounce of *fyle duſt.*

For Rockets of 7, or 8. ounces.

Vnto every pound of *Powder duſt* adde 4. ounces of *Salt peeter* and 3. ounces of *Sulpher.*

Of Rockets of 10, or 12, ounces.

Vnto the precedent *compoſition* adde halfe an ounce of *Sulpher*, and it will be ſufficient.

For Rockets of 14, or 15, ounces.

Vnto every pound of *Powder duſt* adde 4. ounces of *Salt peeter*, of *Cole duſt* 2¼ ounces. of

Sulpher

Sulpher and *fileduſt* of each $1\frac{1}{4}$ ounces.

For Rockets of 1 *pound.*

Vnto every pound of *Powder duſt* adde 3 ounces of *Cole duſt*, and one ounce of *Sulphur*.

Of Rockets of 2 *pound.*

Vnto every pound of *Powder duſt* adde $9\frac{1}{2}$ ounces of *Salt peeter*, of *Cole duſt* $2\frac{1}{2}$ ounces, *fileduſt* $1\frac{1}{2}$ ounces, and of *Sulphur* $\frac{3}{4}$ of ounces.

For Rockets of 3 *pound.*

Vnto every pound of *Salt peeter* adde 6 ounces of *Cole duſt*, and of *Sulpher* 4 ounces.

For Rockets of 4, 5, 6 *or* 7 *pound.*

Vnto every pound of *Salt peeter* add 5. ounces of *Cole duſt* and $2\frac{1}{2}$ ounces of *Sulphur*.

For Rockets of 8, 9 *or* 10 *pound.*

Vnto every pound of *Salt peeter*, adde $5\frac{1}{2}$ ounces of *Cole duſt*, and of *Sulphur* $2\frac{1}{2}$ ounces.

Here note that in all great *Rockets*, there is no *Powder* put, becauſe of the greatneſſe of the fire which is lighted at once, which cauſeth too great a violence, therefore ought to bee filled with a more weaker *compoſition*.

Of the making of Rockets and other Fireworkes.

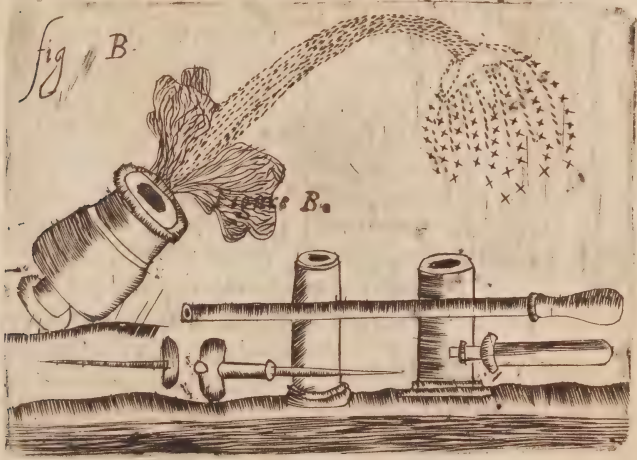
FOr the making of *Rockets* of ſundry kinds, divers molds are to be made, with their *Rowling pins*, *Breathes*, *Chargers*, *&c.* as may be ſeene here in the *figure*. And having rowled a *Caſe* of paper upon the *Rowling pin* for your mould, fill it with the compoſition belonging to that mould as before is delivered:

now may you loade it on the top, with *Serpents*, *Reports*, *Stars*, or *Golden Raine*: the *Serpents* are made about the bigneſſe of ones little finger, by rowling a little paper upon a ſmall ſticke, and then tying one end of it and filling it with the mixt compoſition ſomewhat cloſe, and then tying the other end. The reports are made in their paper *Caſes* as the *Serpents*, but the Paper ſomewhat thicker to give the greater report. Theſe are filled with

Figure A.

graine Powder or halfe *Powder* and halfe compoſition, and tying both ends cloſe, they are finiſhed. The beſt kind of *ſtarres* are made with this mixture following; unto every 4. ounces of *Salt peeter*, adde 2. ounces of *Sulphur*

phur, and to it put 1. ounce of *Powder duſt*, and of this compoſition make your *ſtarres*, by putting a little of it within a ſmall quantity of



towe; and then tying it up in the forme of a ball as great as an *Haſell Nut* or a little *Wallenut*, through which there muſt be drawne a little *Primer* to make it take fire. Touching the making of the *Golden Raine* that is nothing but filling of *Quilles* with the compoſition of your *Rockets* ſomewhat hard: Now if the head of a *Rocket* be loaded with a thouſand of thoſe *Quilles* its a goodly ſight to ſee how pleaſantly they ſpread themſelves in the *Ayre* and come downe like ſtreames of *Gold* much like the falling downe of *Snow* being agitated by ſome turbulent winde.

Of recreative fires.

1 *Philostrates* saith, that if *wine* in a *Platter* bee placed upon a receiver of burning *Coles*, to exhale the spirit of it, and be inclosed within a *Cupboard* or such like place, so that the *Ayre* may nor goe in, nor out, and so being shut up for 30. *yeares*: he that shall open it, having a wax *Candle* lighted, and shall put it into the *Cupboard*; there will appeare unto him the figure of many cleare *starres*.

2 If *Aquavitæ* have *Camphere* dissolved in it; and be evaporated in a close *Chamber*, where there is but a *Charcole fire*, the first that enters into the *Chamber* with a *Candle* lighted, will be extreamely astonished, for all the *Chamber* will seeme to be full of *fire* very subtile, but it will be of little continuance.

3 *Candles* which are deceitfull are made of halfe *Powder*, covered over with *Tallow*; and the other halfe is made of cleane *Tallow*, or Waxe, with an ordinary *weeke*; this *Candle* being lighted and the upper halfe consumed, the *Powder* will take fire, not without great noyse and astonishment to those which are ignorant of the cause.

4 A dozen or twenty small *Serpents* placed secretly under a *Candlesticke* that is indifferent big, which may have a hole passe through the socket of it to the *Candle*, through which a peece of primer may be placed, and setting a small *Candle* in the socket to burne according

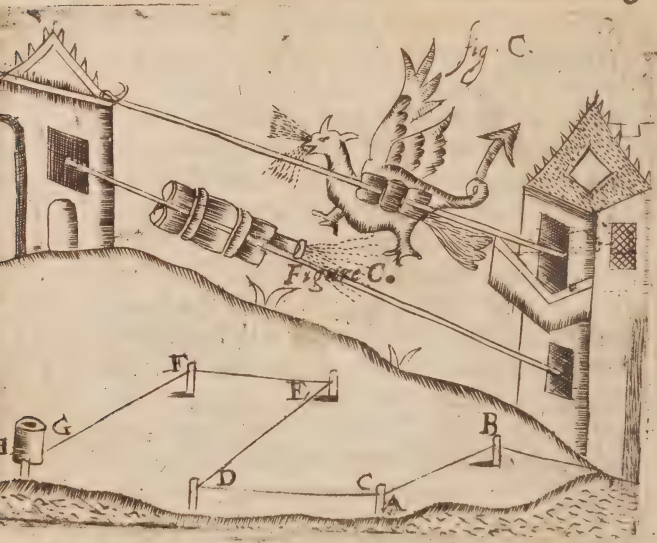
to

to a time limited: which *Candlesticke* may bee set on a side Table without suspition to any; then when the *Candle* is burned, that it fires the primer, that immediatly will fire all the *Serpents*, which overthrowing the *Candlestick* will flye here and there, intermixing themselves, sometimes in the *Ayre*, sometimes in the *Planching*, one amongst another, like the crawling of *Serpents*, continuing for a pretty while in this posture, and in extinguishing every one will give his report like a *Pistoll*; This will not a little astonish some, thinking the house will bee fired, though the whole powder together makes not an ounce, and hath no strength to doe such an effect.

How to make fire runne up and downe, forward and backward.

TAke small *Rockets*, and place the tayle of one to the head of the other, upon a *Cord* according to your fancie, as admit the *Cord* to be *A B C D E F G.* give fire to the *Rocket* at *A*, which will fly to *B*, which will come backe againe to *A*, and fire another at *C*, that will fly at *D*, which will fire another there, and fly to *E*, and that to *F*: and so from *F*, to *G*; and at *G*, may be placed a pot of fire, viz. *G H*: which fired will make good sport, because the *Serpents* which are in it will variously intermix themselves in the *Ayre*, and upon the ground, and every one will extinguish with a report: and here may you note that upon the

Rockets may be placed fierie *Dragons Combatants*, or such like to meete one another, having



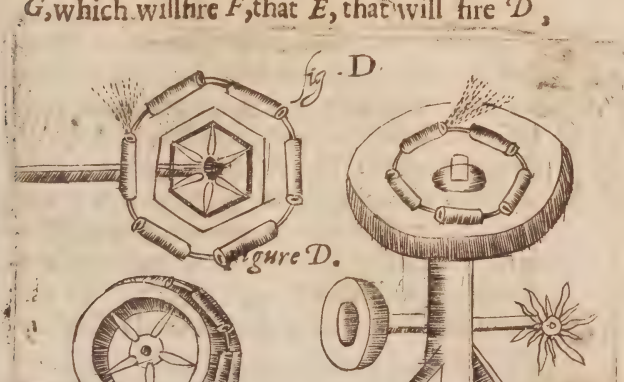
lights placed in the Concavity of their bodies, which will give great grace to the action.

How to make Wheeles of fire.

TAke a *Hoope*, and place two *laths* acrosse one the other; upon the crossing of which make a *hole*, so that it may be placed upon a pin to turne easily, as the figure 2. sheweth: upon the sides of which hoope or round *Circle* place your *Rockets*, to which you may place *Lances* of fire betweene each

Rocket

Rockets: let this wheele be placed upon a ſtandard as here is repreſented, and place a peece of *Primer* from one *Lance* to another, then give fire at *G*, which will fire *F*, that *E*, that will fire *D*,



that *C*, and that will fire the *Rocket* at *A*: then immediatly the wheele will begin to move and repreſent unto the ſpectators a Circle of changeable fire, and if pots of fire be tied to it, you will have fine ſport in the turning of the wheele and caſting out of the *Serpents*.

Of Night Combatants.

Clubbes, *Targuets*, *Faulchons*, and *Maſes* charged with ſeverall *fires*, doe make your nights *Combatants*, or are uſed to make place amongſt a throng of people. The *Clubbes* at the ends are made like a round *Panier* with ſmall

ſmall ſticks, filled with little *Rockets* in a ſpirall forme, glued and ſo placed that they fire but one after another; the *Maſſes* are of diverſ faſhions, ſome made oblong at the end, ſome made of a ſpirall forme, but all made hollow to put in ſeverall *compoſition*, and are boared in divers places, which are for ſundry *Rockets*, and *Lances* of weake compoſition to be fired at pleaſure: The *Faulchons* are made of wood in a bowing forme like the figure *A*, having their backes large to receive many *Rockets*, the head of one neare the necke of another, glued and faſtned well together, ſo that one being ſpent another may be fired: The *Targets* are made of woodden thinne *boards*, which are *chaneled* in ſpirall lines to containe primer

to

to fire the *Rockets* one after another, which is all covered with thinne covering of *wood*, or *Paſtboard*, boared with holes ſpirally alſo; which *Rockets* muſt be glued and made faſt to the place of the *Chanells*: Now if two *men* the one having a *Targuet* in his hand, and the other a *Falchon*, or *Maſſe* of fire ſhall begin to fight, it will appeare very pleaſant to the *Spectators*: for by the motion of fighting, the place will ſeeme to be full of ſtreames of *fire*: and there may be adjoyned to each *Targuet* a *Sunne* or a burning *Comet* with *Lances* of *fire*, which will make them more beautifull and reſplendent in that action.

Of ſtanding Fires.

SVch as are uſed for recreation, are *Colloſſus*, *Statues*, *Arches*, *Pyramedies*, *Charyots*,

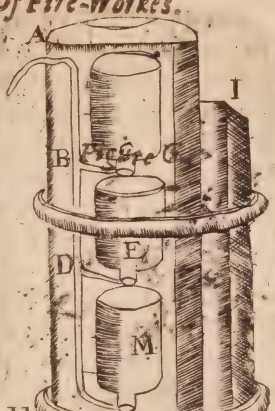
Chaires of triumph & such like, which may be accommodated with *Rockets* of fire, & beautified with sundry other artificiall fires, as pots of fire for the Ayre wch may cast forth severall figures, *Scutchions*, *Rockets* of divers sorts, *Starres*, *Crownes*, *Leaters*, and such like; the borders of which may be armed with sundry *Lances* of fire, of small flying *Rockets* with reports, flames, of small *birds* of *Cypres*, *Lanternes* of fire, *Candles* of divers uses, and colours in burning: and whatsoevr the fancie of an ingenious head may allude unto.

Of Pots of fire for the Ayre, which are throwne out of one Case one after another of a long continuance.

MAke a long *Trunke* as *A G*, and by the side *A H*, let there be a *Chanell* which may be fiered with slow primer or composition; then having charged the *Trunke A G*, with the *Pots* of fire for the *Ayre*, at *I G E C*, and made the *Trunke A G*, very fast unto a *Post* as *I K*, give fire at the top as at *A*, which burning downewards will give fire to *C*, and so throughout that *Pot* in the *Ayre*, which being spent, in the meane time the fire will burne from *B*, to *D*, and so fire *E*, and throw it out also into the *Ayre*, and so all the rest one after another will be throwne out: and if the *Pots* of fire for the *Ayre* which are cast out, bee filled with diverse Fireworkes,

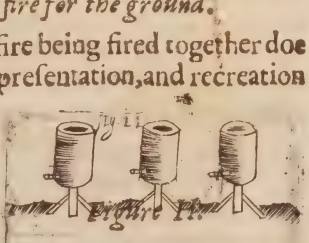
they

they will bee so much the more pleasant to the beholders. These *Trunkes* of fire doe greatly adorne a Fireworke, and may conveniently bee placed at each angle of the whole worke.



Of Pots of fire for the ground.

MAny *Pots* of fire being fired together doe give a fine representation, and recreation to the *spectators*, & cause a wonderfull shout amongst the common people which are standers by; for those *Pots* being filled with *Bulles* of fire and flying *Serpents* for the *Ayre*,



they will so intermix one within another, in flying here and there a little above the ground, and giving such a volley of reports that the *Ayre* will rebound with their noise, and the whole place bee filled with sundry streames

ſtreames of pleaſant fire; which ſerpents will much occupie theſe about the place to defend themſelves in their upper parts, when they will noleſſe be buſied by the balles of fire, which ſeemes to annoy their feete.

Of Balles of fire.

THeſe are very various according to a mans fancie ſome of which are made with very ſmall *Rockets*, the head of one tyed to the neck of another: the ball being made may be covered over with pitch except the hole to give fire to it; this *Ball* will make fine ſport amongſt the ſtanders by, which will take all a fire, and rowle ſometimes this way, ſometimes that way, betweene the legs of thoſe that are ſtanders by if they take not heede, for the motion will be very irregular, and in the motion will caſt forth ſeverall fires with reports. In the ſecond kind there may be a chanell of *Iron* placed in divers places in ſpirall manner, a-

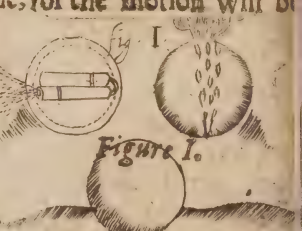


Figure I.

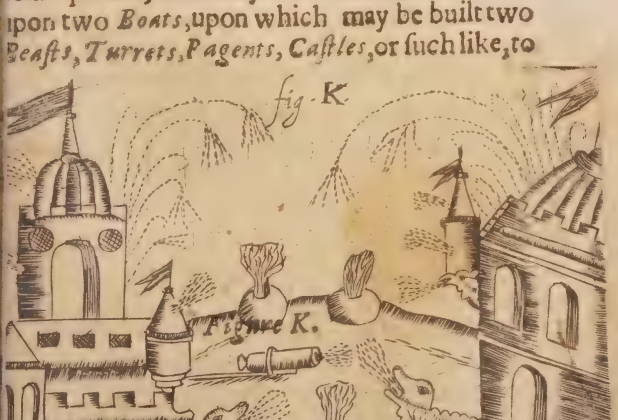
gainſt which may be placed as many ſmall petards of paper as poſſible may be, the Channel muſt be full of ſlow compoſition and may be covered as the former, and made fit with hi *Rockets* in the middle: this *Ball* may bee ſho

ou

out of a mortar *Peece* or charged on the top of a *Rocket*: for in its motion it will fly here and there, and give many reports in the Ayre: because of the discharge of the petards.

Of fire upon the Water.

PLaces which are situated upon *Rivers* or great *Ponds*, are proper to make *Recreative fires* on: and if it be required to make some of consequence, such may conveniently bee made upon two *Boats*, upon which may be built two *Beasts*, *Turrets*, *Pagents*, *Castles*, or such like, to



receive or hold the diversitity of *Fire workes* that may be made within it, in which may play divers *fires*, *Petards*, *&c.* and cast out many simple *Grenades*, *Balls* of fire to burne in the

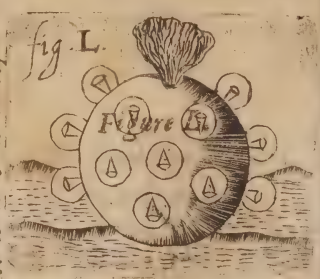
water

water ſerpents and other things, and often times theſe boates in their incounters may hang one in another, that ſo the *Combatants* with the *Targuets*, and *Maſſes* may fight; which will give great content to the eyes of thoſe which are lookers on, and in the concluſion fire one another, (for which end they were made:) by which the dexterity of the one may be knowne in reſpect of the other, and the triumph and victory of the fight gotten.

Of Balles of fire which moves upon the water.

THeſe may be made in forme of a *Ball* ſtuffed with other little *Balls*, glued round about and filled with compoſition for the *water*, which fiered will produce merveilous and admirable effects, for which there muſt be had little Cannons of white *Iron*, as the ends of ſmall funnells; theſe *Iron Cannons* may be peirced in ſundry places, to which holes, may be ſet ſmall *Balles* full of compoſition for the *water*, which ſmall *Balls* muſt be peirced deepe and large, and covered with Pitch, except the hole: in which hole muſt bee firſt placed a little quantitie of graine *Powder*; and the reſt of the hole filled up with compoſition; and note further that theſe *Iron Cannons*, muſt

fig. L.



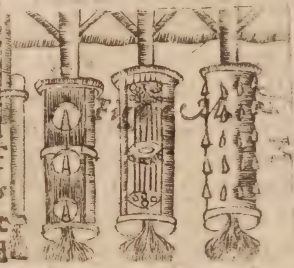
be

be filled with a slow composition; but such which is proper to burne in the *water*: then must these *Cannons* with their small *Balls* bee put so together that it may make a *Globe*, and the holes in the *Cannons* be answerable to the hollow *Balls*, and all covered over with *Pitch* and *Tallow*; afterwards pierse this *Ball* against the greatest *Cannon* (to which all the lesser should answer) unto the composition, then fire it, and when it begins to blow, throw it into the *water*, so the fire comming to the holes will fire the graine *Powder*, the which will cause the *Balls* to separate and fly here and there, sometimes two at a time, sometimes three, sometimes more, which will burne within the water with great astonishment and content to those which see it.

Of Lances of fire.

STanding *Lances of fire*, are made commonly with hollow wood, to containe sundry *Petards*, or *Rockets*, as the figure here sheweth, by which is easie to invent others according to ones fancy. These *Lances* have woodden handles, that so they may be fastned at some *Post*, so that they be not overthrowne in the flying out of the *Rockets* or *Petards*: there are lesser sorts of Lances whose cases are of three or foure fouldings of *Paper* of a foote long, and about the bigneſſe of ones finger, which are filled with a composition for *Lances*. But if these *Lances* be filled with a compositi-

on, then (unto every 4. ounces of powder adde 2. ounces of *Salt Peeter*, and unto that adde 1. ounce of *Sulphur*) it will make a brick fire red before it be halfe spent, if the Lance be fiered and held to it: and if 20. such *Lances* were placed about a great *Rocket* and shot to a *house* or *ship*, it would produce a mischievous effect.



How to shoote a Rocket Horizontall, or otherwise.

VNto the end of the *Rocket* place an *Arrow* which may not be too heavy, but in stead of the feathers let that bee of thinne white tinne plate, and place it upon a rest, as here you may see by the Figure; then give fire unto it, and you may see how serviceable it may bee. To the head of such *Rockets* may be placed *Petards*, *Balls* of fire, *Grenades*, *&c.* and so may be applyed to *warlike affaires*.

How

How a Rocket burning in the water for a certaine time, at last shall fly up in the Ayre with an exceeding quickneſſe.

TO doe this take two *Rockets* the one equall to the other, and joyne them one unto another in the middle at *C.* in ſuch ſort that the fire may eaſily paſſe from one to another: it being thus done, tye the two *Rockets* at a ſticke in *D*, and let it be ſo long and great that it may make the *Rockets* in the *water* hang, or lye upright; then take a packe thread and tye it at *G.* and let it come double about the ſticke *D M.* at *H.* and at that point hang a *Bullet* of ſome weight as *K.* for then giving fire at *A.* it will burne to *B.* by a ſmall ſerpent filled there and tyed at the end, and covered ſo that the water injure it not, which will fire the *Rocket B D*, and ſo mounting quicke out of the *water* by the looſe tying at *C.* and the *Bullet* at the packe thread, will leave the other *Rocket* in the *water*: and ſo aſcend like a *Rocket* in the *Ayre*, to the admiration of ſuch as know not the ſecrecie.

Figure 1.

Of the framing of the parts of a Fire-Worke together that the severall workes may fire one after another.

CAuse a frame to be made as *A B C D.* of two foot square every way, or thereabouts (according to the quantity of your severall workes) then may you at each angle have a great *Lance* of fire to stand, which may cast out *Pots* of fire as they consume: upon the ledges, *A B. B C.* and *C D.* may bee placed small *Lances* of fire about the number of 30. or 60. some sidewise, & others upright, betweene these *Lances* may be placed *Pots* of fire sloping outwards, but made very fast, and covered very close, that they chance not to fire before they should; then upon the ledges *R E. F G. H I.* and *A D.* may be placed your fouciſons, and behind al the work may be set your *Boxes of Rockets*, in each of which you may place 6, 9, 12. or 20. small *Rockets*: Now give fire at *A.* (by helpe of a peece of primer going from one *Lance* to another) all the *Lances* will instantly at once be lighted, and as soone as the *Lance* at *A* is consumed, it will fire the Channell which is made in the ledge of the frame which runnes under the *Pots* of fire, and as the fire goes along burning, the *Pots* will be cast forth, and so the ranke of *Pots* upon the sides of the frame *A B. B C.* and *C D.* being spent, the fouciſons will begin to play being fiered also by a Channell which runnes under them, upon the

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Experiments in Waterworkes.
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Experiments in Fireworkes.
From page,265.to the end.

FINIS.

Recensui hunc librum cui titulus est, Mathamaticall Recreations, *qui quidem liber continet centum, & viginti folia, in quibus omnibus nihil reperio, quod non cum utilitate Publica imprimatur, modo intra septem menses proximè sequentes typis mandetur.*

Ex ædibus Londinenfibus. *Iul.* 23. 1632.

Guil. Bray,
Episcopo Londinensi Capellanus Domesticus.

33. 1816
33. 1817

A

THOUSAND NOTABLE THINGS,

ON VARIOUS SUBJECTS;

DISCLOSED FROM

THE SECRETS OF NATURE AND ART;

Practicable, Profitable, and of great Advantage;

Set down from long and curious Study and Experience, for the greater Part; and the reſt taken from the moſt judicious and celebrated Authors of the Antients and Moderns. Being a RICH CABINET of SELECT CURIOSITIES and RARITIES, in one Volume, digeſted into fourteen Books, for the general Uſe and Good of Mankind; with ſtrict Amendments, and large Additions, to what formerly has been publiſhed in this Kind; exceeding any other for the Multitude of pleaſing Variety herein to be found.

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NO. 71, ST. PAUL'S CHURCH-YARD;
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[Price, ſewed, 1s. 6d.]

TO THE READER.

IF some think no Shame to pleasure many for the displeasuring of a few, (gentle Reader) then I need not to blush; nor fear to profit many, by hurting of none; which I hope I have done, by publishing of this my Book abroad, nor penn'd without Pain, nor drawn without Diligence, nor ended with Ease. Wherein are such, and so many, notable, rare, pleasant, profitable, and precious Things (meaning one with another) as never were yet set forth in any Volume in the English Tongue. Divers of them were never hitherto printed nor written that ever I knew; but only that I wrote them at such Time as I heard them credibly reported, thinking them such rare Things as were worthy to be registered. I must confess I have selected and pick'd a great many out of Latin Writers; the Authors and Writers whereof I have named, most commonly, at the End of the same. And some notable and precious Things I gathered out of some old English written Books; and some also not long since printed, unworthy to be hid, and greater Pity but they should be known, which purposely I have placed herein; whereby I think verily many will read them, hear them, and have Profit by them, that otherwise should never have known them. For many, I suppose, will buy this Book for Things whereunto they are affectionated, that never could, or would, have bought, or looked on the Books wherein they all are. So that, by this Means, they are like to win against their Wills.

Per-

Perhaps you may marvel, that I have not placed them in better Order, and that Things of like Matter are not joined together. Truly, there are so many of so divers and sundry Sorts, and contrary Effects, that it could not be altogether observed. And in my Judgment, through the Strangeness and Variety of Matter, it will be more desirously and delightfully read; knowing we are made of such a Mould, that delicate Daintiness delights us much, but we are loath to be fed too long with one Food; and that long walking, in strange, pleasant, and contrary Places, will lesser weary us, than short travel in often-trodden Ground.

This Work might have been framed with finer Phrases (more delectable to some, though not so meet for many) but that it is better to profit a greater Sort, than to feed the Fancies of a few; well assured, that the learned Eloquent can better perceive plain Speechees, than the slenderly Learned, and common Sort, can understand eloquent Discourses.

Therefore, as I have written to all indifferently, so wish I to manifest the Meaning thereof accordingly; who am your Friend, to serve you,

THE AUTHOR.

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